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A USER'S MANUAL FOR THE SEQUENCE ACCOUNTABLE FATIGUE ANALYSIS COMPUTER PROGRAM

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NOTICE

This Technical Report has been reviewed and is approved.

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This report presents a detailed description of a computer program to calculate cumulative damage of notched structural members subjected to arbitrary spectra. The Sequence Accountable Fatigue Analysis computer program develops its sequence sensitivity by tracking residual stresses local to a notch throughout the spectrum of loads. Residual stress relaxation analysis is included to increase the generality of the results. An example spectrum and resulting cumulative damage analysis are illustrated.

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FOREWORD

This program was prepared by J. M. Potter of the Solid Mechanics Branch and R. A. Noble of the Experimental Branch, Structures Division, Air Force Flight Dynamics Laboratory. The work was conducted in-house under Project 1347 "Structural Testing of Flight Vehicles", Task 134704 "Structural Testing Criteria". This report covers work accomplished over a time period of 1 October 1972 to 1 May 1973. The essence of the analysis was presented in AFFDL-TM-73-131-FBR in October 1973.

This manuscript was released by the authors in January 1974.

ABSTRACT

This report presents a detailed description of a computer program to calculate cumulative damage of notched structural members subjected to arbitrary spectra. The Sequence Accountable Fatigue Analysis computer program develops its sequence sensitivity by tracking residual stresses local to a notch throughout the spectrum of loads. Residual stress relaxation analysis is included to increase the generality of the results. An example spectrum and resulting cumulative damage analysis are illustrated.

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SYMBOLS

σ_{res}	Residual stress
σ_{max}	Maximum local stress level
σ_{min}	Minimum local stress level
σ_{ys}	Yield stress
$\sigma_{res_{EQ}}$	Equilibrium component of the residual stress
ε_t	Local strain, total
ε_e	Elastic component of total strain
ε_p	Plastic component of total strain
$\varepsilon_{f'}$	Strain intercept at one reversal on a log ε_p-log life curve
c	Slope of the log ε_p-log life curve
S_{max}	Maximum applied stress level
S_{min}	Minimum applied stress level
S_{mean}	Mean applied stress level, $(S_{max}+S_{min})/2$
K_t	Elastic stress concentration Factor
D	Damage
I	Integer describing the level number
N_{EP}	Equilibrium period, number of cycles for the local stresses to return approximately to the equilibrium conditions following an overload
C1	Residual stress relaxation constant
E1, E2	Relaxation function exponents
N	Number of cycles
E	Modulus of elasticity
N_f	Number of cycles of life at a given stress or strain cycling level

SECTION I

INTRODUCTION

Cumulative damage analyses based upon the local stress-strain behavior at a notch appear to be reasonably successful in anticipating trends in fatigue life behavior of notched specimens subjected to spectrum loading [1-6]. The type of behavior that usually occurs is that peak tensile loads tend to increase the fatigue life and peak compressive loads tend to decrease the life of notched structures compared to structures experiencing load spectra not having those peaks [5,6]. Local behavior analyses, such as those developed by Smith [7] and Neuber [8], help to explain this phenomenon as being a result of the tensile peak load creating a compressive residual stress at the notch and, conversely, the compressive peak creating a tensile residual stress. The change in life occurs because the residual stress state modifies the subsequent damage accumulation rates.

The Sequence Accountable Fatigue Analysis computer program was developed to incorporate the local stress-strain approach with a recent residual stress relaxation analysis [6] in order to improve the sequence sensitivity of cumulative damage analysis. This technical memorandum presents the details of the resultant computer program and an example of its use. The correlation of predictions made with this analysis to actual results of tests experiencing spectrum loading is presented by Potter [9], and Potter, Gallagher, and Stalnaker [10].

SECTION II

PROGRAM OUTLINE

The Sequence Accountable Fatigue Analysis traces the stress-strain behavior local to a notch throughout an applied load spectrum and calculates the damage based on the local experience. The computer program is divided generally into the four parts or modules outlined in Fig. 1.

The basic input data for the material, specimen geometry, fatigue behavior qualities and spectrum, are developed in Module I. The information required in Module I is discussed further in Section III. Module II takes the input information and determines the local stress-strain behavior. Module III references the Range Pair Counting Method Subroutine to cycle count the local stress spectrum. Module IV determines the damage in the local stress-strain spectrum.

The basic analyses used in Modules II, III and IV are presented below.

Module II - Local Stress-Strain Behavior - The analysis used during the determination of the local stress behavior during the spectrum of loading is a combination of analyses developed by Smith [7], Neuber [8] and Potter [6]. Smith's simple analysis indicated that the residual stress could be approximated by assuming that the initial stress-strain behavior was elastic upon unloading following plastic flow. Thus, the residual stress could be calculated knowing the

maximum local stress and the maximum applied stress as in Eq. 1 and in Fig. 2.

$$\sigma_{res_i} = \sigma_{max_i} - K_t S_{max_i} \qquad (1)$$

The Sequence Accountable Fatigue Analysis computer program currently incorporates elastic-perfectly plastic stress-strain behavior. Therefore, σ_{max_i} is equal to the yield stress. For the cycles immediately following the peak stress, the residual stress determined in Eq. 1 modifies the elastic solution as shown in Eqs. 2 and 3 (provided that the following maximum applied stress is less than S_{max} and that there is no change in the residual stress due to a minimum applied stress causing reversed yielding).

$$\sigma_{max_i} = \sigma_{res_{i-1}} + K_t S_{max_i} \qquad (2)$$

$$\sigma_{min_i} = \sigma_{res_{i-1}} + K_t S_{min_i} \qquad (3)$$

The analysis developed by Neuber [8] has been extended to cyclic loading by Wetzel [2] and Wetzel, Morrow and Topper [3] and used by many others [1,4-6] primarily to determine local stress-strain behavior. It is used in this program only to calculate plastic strains occurring when the residual stress undergoes a step change. The plastic strain calculation routine is accessed only when the σ_{max_i} or σ_{min_i} terms in Eqs. 2 and 3 exceed tensile or compressive yield stress levels, respectively. Figure 3 illustrates the calculation of the plastic strain.

The local stress-strain behavior, according to Wetzel [2] is related to the applied load by Eq. 4

$$\sigma \cdot \varepsilon = (K_t S_{max})^2/E \qquad (4)$$

The plastic strain can be found by subtracting the elastic component from the total strain.

$$\varepsilon_p = \varepsilon_t - \varepsilon_e = (K_t S_{max})^2/E \cdot \sigma_{max} - \sigma_{max}/E$$

Therefore, the plastic strain associated with S_{max_i} is given in Eq. 5.

$$\varepsilon_{p_i} = (K_t S_{max_i})^2/E\sigma_{ys} - \sigma_{ys}/E \tag{5}$$

If a residual stress existed prior to this plastic strain excursion, the plastic strain associated with that prior excursion is subtracted from Eq. 5 as shown in Eq. 6.

$$\varepsilon_{p_i} = (K_t S_{max_i})^2/E\sigma_{ys} - (\sigma_{ys} - \sigma_{res_{i-1}})^2/E\sigma_{ys} \tag{6}$$

A similar calculation is made for plastic strains occurring during the minimum stress peak.

In the analysis developed by Potter [6] the residual stress cyclically relaxes toward zero or an equilibrium residual stress as shown in Fig. 4 according to Eq. 7.

$$\sigma_{res_{N=1,2,\ldots}} = (\sigma_{res_{N=1}} - \sigma_{res_{EQ}})\exp(N/N_{EP_i}\ln(0.1)) \tag{7}$$

The N_{EP} term, the Equilibrium Period, is dependent upon the applied stress and the Residual Stress Relaxation Constant.

$$N_{EP_i} = (C1/\left|K_t S_{max_i}\right|^{E1} \cdot \left|K_t S_{mean_i}\right|^{E2}) \tag{8}$$

The Residual Stress Relaxation Constant, C1, has not yet been experimentally defined but should be a constant for a material.

Module III - Cycle Counting Method

After the local stress and plastic strain behavior is calculated, the local stress spectrum is Range Pair Counted using a computer program developed by Tischler.[11]

Module IV - Damage Calculation

Damage is calculated separately for the plastic strain excursions and the elastic stress spectrum. The damage is determined from the conventional $D = \sum \frac{n}{N}$ calculation. Damage from each of the plastic strain cycles is determined from the Coffin-Manson [12] form

$$D_i = 1./N_{f_i} = 1./(\varepsilon_{p_i}/\varepsilon_f')^{1/c}$$

Damage from the elastic stress cycles is determined in a similar manner. The maximum and minimum local stress levels are sequentially compared to unnotched S-N data in a Modified Goodman Diagram format. Damage is summed, and failure of the coupon is defined as the event occurring when the summed damage equals unity.

SECTION III

INPUT DATA REQUIREMENTS

In general, each spectrum analyzed will require slightly different programming in order to get the load history into a usable format for the core program. The basic program requires a certain family of information before any analytical predictions can be made. Appendix I contains a program listing for the Sequence Accountable Fatigue Analysis. The subroutine CORE which accesses the subroutines having to do with RPCM, the Range Pair Counting Method, contains the basic analysis. Subroutine SAL reads the data input and then references subroutine CORE. The subroutine SAL shown is one in which a block of cycles is repeated with optional cycles. A list of the input data cards and the resulting analysis is given in Appendix II.

The specific data requirements are given below.

1. Stress-Strain Behavior - The stress-strain behavior is presumed to be elastic-perfectly plastic with the tensile yield stress being equal to the compressive yield stress. The yield stress value used is an average of the monotonic behavior generally being above the 0.2% yield value and below the engineering ultimate strength.

2. Residual Stress Relaxation - The residual stress relaxation behavior of Eq. 7 and 8 is characterized by C1, the Residual Stress Relaxation Constant and E1 and E2, the relaxation equation exponents. The Residual Stress Relaxation Constant, C1, has not yet been adequately determined. It should be a material property if the relaxation function

is correct and must be assumed. A reasonably accurate estimate of the Residual Stress Relaxation Constant for aluminum material falls in the range of 5-20 x 10^6 (cycles) $(Ksi)^2$. Further experimentation on the part of the analyst should develop a C1 usable for his set of conditions until actual measurement of residual stress relaxation behavior defines the relaxation function and constants. At present E1 and E2 are considered to be equal to 1.0.

3. Specimen Geometry - The elastic K_t value (if available) is entered into the analysis. If that value is not available then an estimate from some other method may be used. In certain cases, a value may be determined from a constant amplitude fatigue test of a similar structure by fitting several values of K_t to the analysis and determining the best correlation as is done with the K_f solution. Once a stress concentration factor, K_t, is determined for a specimen, that value is not changed from test-to-test of the same coupon configuration.

4. Load Multiplier - Different spectra are presented for analysis in different manners. Some data are presented in percent of maximum stress, others in terms of nominal stress, and others in terms of bending moment. The value of the load multiplier defines the nominal stress history.

5. Cumulative Damage Analysis - The damage from the range-paired elastic stress spectrum is determined by calculating a simple $\frac{n}{N}$ value for each level and accumulating the total. The N_{f_i} value is determined from unnotched coupon S-N data in the Modified Goodman Diagram format.

The program requires the input of four second order equations describing the maximum and minimum stress levels at lives of 10^4, 10^5, 10^6 and 10^7 cycles. The coefficients of the equations are derived by least square fitting the S-N data presented in the form of Eq. 9.

$$S_{max} = A(I) S_{min}^2 + B(I) S_{min} + C(I) \qquad (9)$$

The A, B, and C coefficients for several typical materials are presented in Appendix IV. The S-N data shown was derived from various sources but usually from the MIL-HDBK-5A [13]. The C coefficients correspond to the maximum stress level at zero to maximum applied stress conditions on the unnotched coupons.

The damage from the plastic strain cycles is determined using the Coffin-Manson relation to calculate the N_{f_i} value. The conventional plastic strain intercept at one reversal and the ε_p - life slope values are used in the analysis. Specific measured values from the literature are used when available and typical values when they are not available.

6. <u>Analysis or Test Spectrum</u> - The last information needed is the order and magnitude of application of the spectrum used in the test.

SECTION IV

OUTPUT OPTIONS

The Computer Program prints the following output in the process of the analysis.

1. Maximum and minimum applied stress and local stress response through the spectrum. Also printed out is the residual stress, equilibrium stress, applied cycles, and the equilibrium period.

2. The elastic local stress history as input into the Range Pair Subroutine and the resulting Range Paired spectrum.

3. The plastic strain occurrence during the spectrum and the damage associated with each strain reversal.

4. The accumulated damage associated with the plastic strains.

5. The Range Paired elastic stress spectrum and the damage associated with each level.

6. The accumulated damage associated with the current block of loading including the plastic strain damage and the total damage since the initiation of cycling.

At the option of the analyst, he can print out all the above items or only two. The IPRINT value controls what data is printed.

If IPRINT = 1, all six items are printed for each flight or block.

If IPRINT = 2, all items except 2. above are printed.

If IPRINT = 3, only items 4. and 6. above are printed.

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12. Grover, H. J., _Fatigue of Aircraft Structures_, NAVAIR 01-1A-13, Naval Air Systems Command, Washington, D. C., 1966.

13. _Metallic Materials and Elements for Aerospace Vehicle Structures_, MIL-HDBK-5A, Department of Defense, Washington, D. C., Feb. 1966.

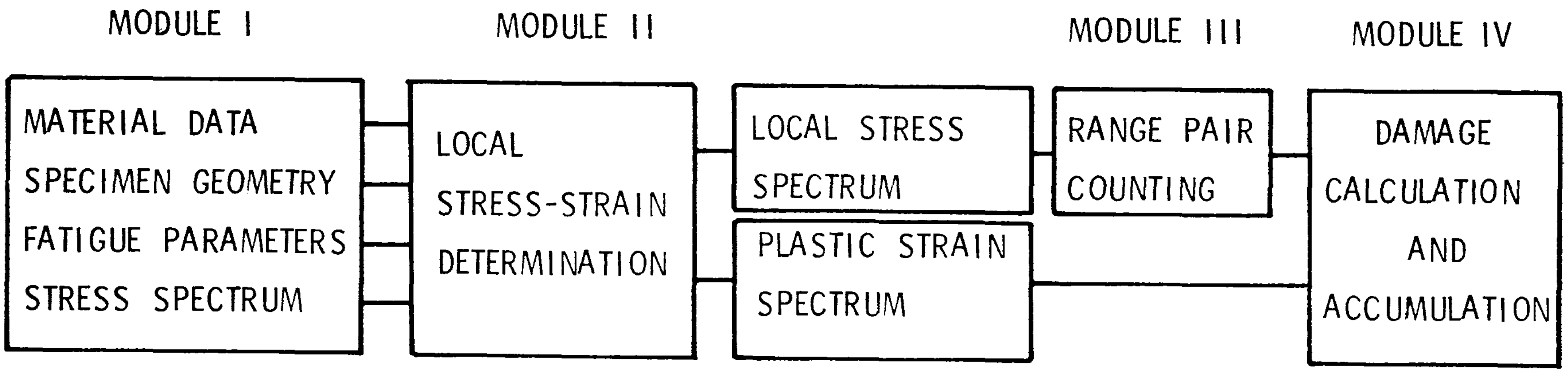


FIGURE 1. PROCEDURE USED IN THE SEQUENCE ACCOUNTABLE FATIGUE ANALYSIS

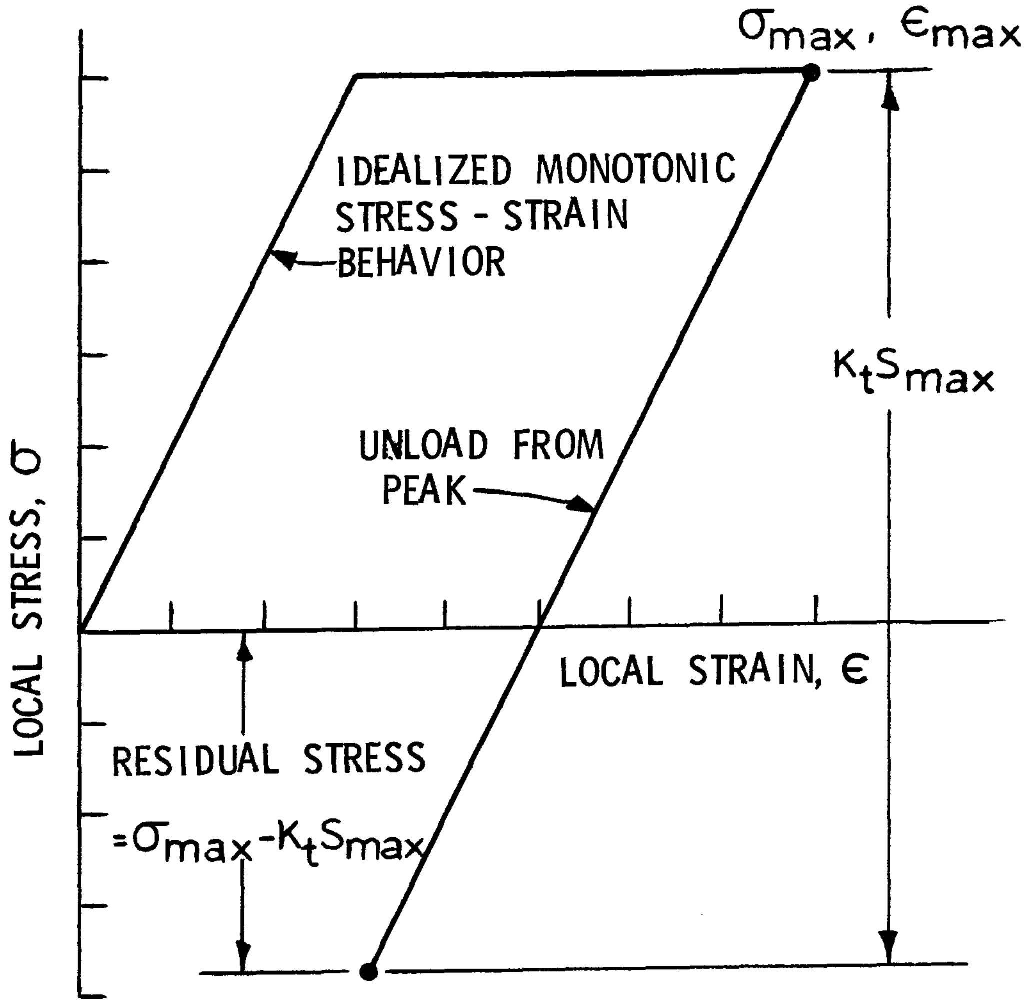


FIGURE 2. METHOD OF DETERMINING THE RESIDUAL STRESS FOLLOWING A PEAK LOAD

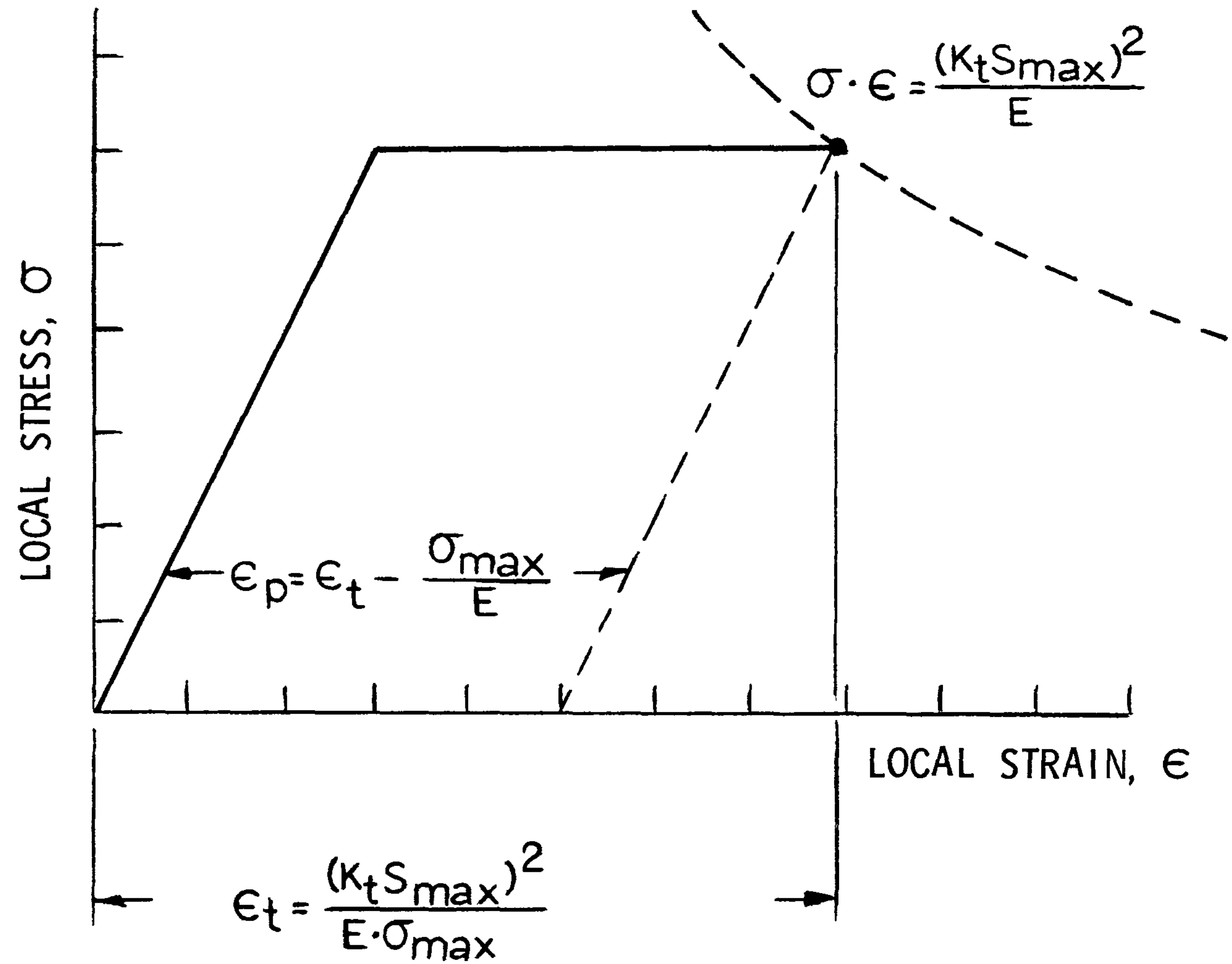
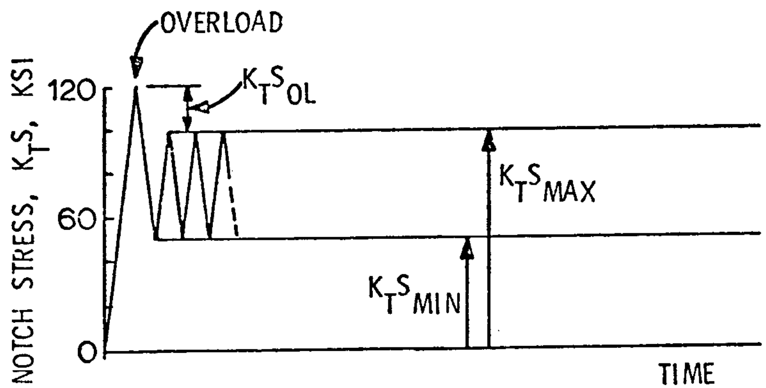
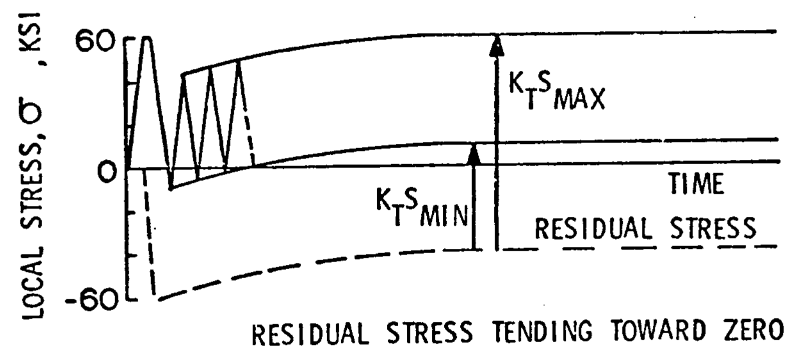


FIGURE 3. METHOD OF DETERMINING PLASTIC STRAIN LEVELS



APPLIED STRESS HISTORY



LOCAL STRESS RESPONSE

FIGURE 4. LOCAL STRESS RESPONSE FOR APPLIED CONSTANT AMPLITUDE LOADING WITH RESIDUAL STRESS RELAXATION

APPENDIX I

PROGRAM LIST

```
PROGRAM     SAL                              CDC 6600 FTN V3.0-367A OPT=1  04/26/74  10.41.32.      PAGE      1

            PROGRAM SAL(INPUT,TAPE5=INPUT,OUTPUT,TAPE6=OUTPUT)
      C
      C    ************************************************************************
      C
      C
      C                             MODULE I
      C                    INPUT ROUTINE FOR THE
      C     SEQUENCE ACCOUNTABLE FATIGUE ANALYSIS
      C
      C    ************************************************************************
      C
      C            PROGRAM DEVELOPED BY  JOHN M. POTTER AND ROBERT A. NOBLE
      C                OF THE AIR FORCE FLIGHT DYNAMICS LABORATORY
      C                     MARCH 1973
      C                  ADDRESS; AFFDL/FBR
      C                          WRIGHT-PATTERSON AFB,OHIO  45433
      C                  TELEPHONE  (513) 255-6104  OR  255-6106
      C
      C     INPUT
      C
      C
      C     DATA CARD 1.     NDECK = THE NUMBER OF DATA DECKS TO BE RUN SEQUENTIALLY.
      C                      IPRINT   THE VALUE CONTROLLING THE WRITE STATEMENTS
      C                                 1  PERMITS MAXIMUM PRINTOUT
      C                                 2  SUPPRESSES RANGE-PAIR PRINTING
      C                                 3  MAXIMUM SUPPRESSION OF PRINTOUT
      C                      IRPCM= THE VALUE CONTROLLING THE ENTRY INTO THE
      C                             RANGE PAIR COUNTING SUBROUTINE
      C                                 1  ENTER RANGE PAIR COUNTING SUBROUTINE
      C                                 2  SKIP RANGE PAIR COUNTING SUBROUTINE
      C                      FORMAT   3I4
      C
      C     EACH DATA DECK CONTAINS THE FOLLOWING CARDS --
      C
      C     CARD 1.       TEST IDENTIFYING INFORMATION
      C                   FORMAT  8A8
      C
      C     CARD 2.       TM     = MATERIAL TYPE
      C                   TYS    = TENSILE YIELD STRESS (KSI)
      C                   EPSD   = LCF STRAIN INTERCEPT
      C                   COFMAN = INVERSE OF COFFIN-MANSON SLOPE
      C                   ELMOD=  MODULUS OF ELASTICITY  (KSI)
      C                   FORMAT 2A8,3F18.5,F10.2
      C
      C     CARDS 3,...,6.  A(N)   N=4,7   (A,B,C ARE COEFFICIENTS OF SECOND
      C                                    (ORDER LEAST SQUARE FIT OF S-N DATA,
      C                     B(N)           (FOR CURVE OF 10**N CYCLES.)
      C                     C(N)           (STMAX = A(N)*STMIN**2 + B(N)*STMIN + C(N))
      C                     TITLE1         (TITLE1,TITLE2 IDENTIFIES THE      )
      C                     TITLE2         (SOURCE OF THE S-N DATA            )
      C                     N              (PUNCHED IN COLUMN 72. FOR INFO.)
      C                     MATERIAL TYPE  (COLUMNS 73-80. FOR INFO ONLY.  )
      C                     FORMAT 3F18.5,2A8
      C
      C     CARD 7.       C1                (CONSTANTS TO BE USED IN CALCULA-.)
```

```
C              E1                 (TION OF EQUILIBRIUM PERIOD, ENEP.)
C              E2                 (ENEP=C1/(KTSMAX**E1*KTSMEAN**E2) )
C              FORMAT  3F18.5
C
C    CARD 8.   AKT = STRESS CONCENTRATION FACTOR USED THE FIRST
C                    TIME THROUGH THE PROGRAM
C              FORMAT   F18.5
C
C    CARD 9.   NBLOCK = NUMBER OF BLOCKS (NO. OF TIMES TO REPEAT LIST
C                                                           OF LOADS)
C              NLEVEL = NUMBER OF LOADS
C              NTYPE  = NUMBER OF TYPES OF LOADS
C              FORMAT  3I10
C
C    CARD 10.  TLL = LIMIT LOAD
C              FORMAT  F18.5
C
C    CARDS 11,...,NLEVEL + 10.
C              K              THE KTH STEP        (K=1,NLEVEL)
C              ITYPE(K) = THE IDENTIFYING TYPE OF THE KTH LOAD
C              STMIN(K) = THE KTH MINIMUM (DECIMAL FRACTION OF TLL)
C              STMAX(K) = THE KTH MAXIMUM (DECIMAL FRACTION OF TLL)
C              ENN(K)   = NUMBER OF CYCLES AT THE KTH LOAD
C              FORMAT  2(I4,2X),3(F18.5,1X)
C
C    CARDS NLEVEL + 11,...,NLEVEL + 10 + NBLOCK.
C              JJ                  THE JJTH BLOCK       (JJ=1,NBLOCK)
C              NN(JJ,1)    = TYPE OF LOAD INCLUDED IN JJTH BLOCK
C              NN(JJ,2)    =       (THERE WILL BE ONE NN VALUE      )
C              NN(JJ, )    =       (ON THE CARD FOR EACH DIFFERENT )
C              FORMAT  9I5         (TYPE OF LOAD INCLUDED IN THE    )
C                                  (JJTH BLOCK                      )
C
      COMMON/MSAL/RNCYC(200),KPMAX,IPRINT
      DIMENSION RTMIN(200),RTMAX(200),RNN(200),ITYPE(200)
      COMMON/MCOR1/NLEVEL,IRPCM,IPLOT,ELMOD,TYS,EPSO,COFMAN,C1,E2,E1,
     *RES(200),AKT,SUMENN,SUMNC
      COMMON/MCOR2/STMIN(200),STMAX(200),ENN(200),A(10),B(10),C(10),
     *R(10),NN(20,10)
      READ(5,4) NDECK,IPRINT,IRPCM
    4  FORMAT(3I4)
      WRITE(6,3) NDECK
    3 FORMAT(1H1,I4,32H DATA DECKS ARE TO BE PROCESSED.)
      IF(IRPCM.GE.2)GO TO 6
      WRITE(6,11)
      GO TO 13
    6 WRITE(6,7)
    7 FORMAT(25H NO COUNTING METHODS USED)
   13 CONTINUE
      DO 595 LMN = 1,NDECK
      WRITE(6,5)
    5 FORMAT(40H SEQUENCE ACCOUNTABLE FATIGUE EVALUATION)
      READ(5,9)T1,T2,T3,T4,T5,T6,T7,T8
    9  FORMAT(8A8)
      WRITE(6,8)T1,T2,T3,T4,T5,T6,T7,T8
```

```
      8     FORMAT(16H1SPECTRUM FROM  ,8A8)
      C
      C          INPUT OF DATA PECULIAR TO A MATERIAL
      C
            READ(5,10)TM1,TM2,TYS,EPSD,COFMAN,ELMOD
      10    FORMAT(2A8,3F18.5,F10.2)
            WRITE(6,12)TM1,TM2,TYS,EPSD,COFMAN,ELMOD
      12    FORMAT(18H MATERIAL TYPE -- ,2A8,//30H TENSILE YIELD STRESS (KSI)
           *--,F18.5,//23H LCF STRAIN INTERCEPT =,F18.5,//31H INVERSE OF COFFI
           *N-MANSON SLOPE,F18.5,//18H ELASTIC MODULUS =,F18.5)
            READ(5,14)  (A(N),B(N),C(N),TITLE1,TITLE2,N=4,7)
      14    FORMAT(3F18.5,2A8)
            WRITE(6,16)
      16    FORMAT(58H0COEFFICIENTS OF SECOND ORDER LEAST SQUARE FIT OF S-N DA
           *TA)
            WRITE(6,18)
      18    FORMAT(44H       SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I))
            WRITE(6,20)
      20    FORMAT(5X,5H LIFE,10X,5H A(I),14X,5H B(I),14X,5H C(I))
            WRITE(6,22)(N,A(N),B(N),C(N),N=4,7)
      22    FORMAT(8H    10**,I2,3F18.5)
            WRITE(6,56) TITLE1,TITLE2
      56    FORMAT(39H0UNNOTCHED COUPON S-N DATA DERIVED FROM/28H INFORMATION
           *SUPPLIED FROM  ,2A8)
            READ(5,14) C1,E1,E2
            WRITE(6,24)
      24    FORMAT(36H0RESIDUAL STRESS RELAXATION FUNCTION)
            WRITE(6,26)
      26    FORMAT(/42H       ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)/)
            WRITE(6,28) C1,E1,E2
      28    FORMAT(13H+WHERE   C1 =,E15.8,9H ,    E1 =,F10.3,10H AND  E2 =,F10.
           *3)
      C
      C
      C
      C          INPUT OF DATA PECULIAR TO A SEQUENCE
      C
      C
            READ(5,65)AKT
      65     FORMAT(F18.5)
            READ(5,32) NBLOCK,JLEVEL,NTYPE
      32    FORMAT(3I10)
            WRITE(6,34) NBLOCK,JLEVEL
      34    FORMAT(// I10,23H TIMES THROUGH BLOCK OF,I10,6H LOADS)
            READ(5,35) TLL
      35    FORMAT(F18.5)
            WRITE(6,33) TLL
      33    FORMAT(/ 5X,13H LOAD LIMIT =,F18.5)
            READ(5,36)(IDUMMY   ,ITYPE(K),RTMIN(K),RTMAX(K),RNN(K),K=1,JLEVEL)
      36    FORMAT(I4,2X,I4,2X,F18.5,1X,F18.5,1X,F18.5,1X)
            WRITE(6,38)
      38    FORMAT(//11H STEP  TYPE,10X,6H STMIN,14X,6H STMAX,15X,4H ENN)
            WRITE(6,36)(    K    ,ITYPE(K),RTMIN(K),RTMAX(K),RNN(K),K=1,JLEVEL)
            WRITE(6,39)
      39    FORMAT(//47H BLOCK  TYPE TYPE TYPE TYPE TYPE TYPE TYPE TYPE/)
```

```
      DO 42 JJ=1,NBLOCK
      READ(5,40) IDUMMY     ,(NN(JJ,KK),KK=1,NTYPE)
      WRITE(6,40)     JJ     ,(NN(JJ,KK),KK=1,NTYPE)
   40 FORMAT(9I5)
   42 CONTINUE
      SUMENN=0.
      SUMNC=0.
      RES(1)=0.
       WRITE(6,8)T1,T2,T3,T4,T5,T6,T7,T8
      WRITE(6,51) (AKT)
   51 FORMAT(/7H AKT = ,(F6.2))
        WRITE(6,55)C1
   55 FORMAT(//24H RELAXATION CONSTANT C1=,F15.2)
       IF(IRPCM.GE.2)GO TO 59
      WRITE(6,11)
   11 FORMAT(56H0SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE)
     *)
   59 CONTINUE
      DO 1002 KFL=1,NBLOCK
       JJJ=1
      DO 60 J=1,JLEVEL
      DO 70 KK=1,NTYPE
       IF(NN(KFL,KK).EQ.0) GO TO 60
       IF(ITYPE(J).EQ.NN(KFL,KK))GO TO 150
   70 CONTINUE
  150  STMIN(JJJ)=RTMIN(J)*TLL
       STMAX(JJJ)=RTMAX(J)*TLL
       ENN(JJJ)=RNN(J)
      JJJ=JJJ+1
   60 CONTINUE
       NLEVEL=JJJ-1
      CALL CORE(KFL)
       IPRINT=2
 1002 CONTINUE
  597 CONTINUE
  595 CONTINUE
  596 CONTINUE
  580 STOP
      END
```

```
SUBROUTINE  CORE                                              CDC 6600 FTN V3.0-367A OPT=1  04/26/74  10.40.58.      PAGE      1

              SUBROUTINE CORE(KFL)                                               CORE       2
      C       ****************************************************************** CORE       3
      C                                                                          CORE       4
      C                         CORE PROGRAM OF                                  CORE       5
      C                    THE SEQUENCE ACCOUNTABLE FATIGJE ANALYSIS             CORE       6
      C                                                                          CORE       7
      C                                                                          CORE       8
      C                              MODULE II                                   CORE       9
      C                                                                          CORE      10
      C                    LOCAL STRESS AND STRAIN DETERMINATION                 CORE      11
      C                                                                          CORE      12
      C       ****************************************************************** CORE      13
      C                                                                          CORE      14
              COMMON/MDEC1/SIGMAX(200),SIGMIN(200)                               CORE      15
              COMMON/MSAL/RNCYC(200),KPMAX,IPRINT                                CORE      16
              DIMENSION PLSTRA(200),EN(200),EX(200)                              CORE      17
              COMMON/MCOR1/NLEVEL,IRPCM,IPLOT,ELMOD,TYS,EPSO,COFMAN,C1,E2,E1,    CORE      18
             *RES(200),AKT,SUMENN,SUMNC                                          CORE      19
              COMMON/MCOR2/STMIN(200),STMAX(200),ENN(200),A(10),B(10),C(10),     CORE      20
             *R(10),NN(20,10)                                                    CORE      21
              JJ=KFL                                                             CORE      22
              IF(JJ.GT.3) IPRINT=3                                               CORE      23
              IRAIN=1                                                            CORE      24
              WRITE(6,54)JJ                                                      CORE      25
      54      FORMAT(20H FLIGHT OR BLOCK NO.,I5)                                 CORE      26
              IF(IPRINT.GE.3) GO TO 61                                           CORE      27
              WRITE(6,62)                                                        CORE      28
      62      FORMAT(66H STMAX    STMIN    SIGMAX  SIGMIN   RES    EQRES     ENN   CORE      29
             *       NEP)                                                        CORE      30
      61      CONTINUE                                                           CORE      31
      C                                                                          CORE      32
      C                                                                          CORE      33
      148     DO 570 J=1,NLEVEL                                                  CORE      34
      149     I=J+1                                                              CORE      35
              PLSTRA(J)=0.                                                       CORE      36
      C                                                                          CORE      37
      C         DETERMINE SEQUENCE ACCOUNTABLE RESIDUAL STRESS AND CORRESPONDING CORE      38
      C           PLASTIC STRAIN                                                 CORE      39
      C                                                                          CORE      40
      150     ASMAX=AKT*STMAX(J)                                                 CORE      41
              ASMIN=AKT*STMIN(J)                                                 CORE      42
              ASMEAN=(ASMAX+ASMIN)/2.                                            CORE      43
              JA=0                                                               CORE      44
      170     IF(RES(I-1)+ASMIN+TYS) 190,190,200                                 CORE      45
      190     JA=1                                                               CORE      46
              AAA=RES(I-1)+ASMIN                                                 CORE      47
              PLSTRA(J)=    -1.*(AAA/ELMOD)*(1.+AAA/TYS)                         CORE      48
      200     JB=0                                                               CORE      49
      202     IF(RES(I-1)+ASMAX-TYS) 220,210,210                                 CORE      50
      210     JB=-1                                                              CORE      51
              AAA=ASMAX                                                          CORE      52
              BBB=TYS-RES(I-1)                                                   CORE      53
              IF(BBB.GE.TYS) GO TO 214                                           CORE      54
      212     BBB=0.                                                             CORE      55
      214     PLSTRA(J)=    AAA*AAA/(ELMOD*TYS)-BBB*BBB/(ELMOD*TYS)              CORE      56
```

```
  220  IF(JA+JB) 230,250,240                                          CORE    57
  230  RES(I)=TYS-ASMAX                                               CORE    58
       GO TO 290                                                      CORE    59
  240  RES(I)=-TYS-ASMIN                                              CORE    60
       GO TO 290                                                      CORE    61
  250  IF(JA) 260,260,270                                             CORE    62
  260  RES(I)=RES(I-1)                                                CORE    63
       GO TO 290                                                      CORE    64
  270  RES(I)=-ASMEAN                                                 CORE    65
  290  SIGMAX(IRAIN)=RES(I)+ASMAX                                     CORE    66
       SIGMIN(IRAIN)=RES(I)+ASMIN                                     CORE    67
       RNCYC(IRAIN)=ENN(J)                                            CORE    68
       IF(ASMAX.LE.TYS) GO TO 410                                     CORE    69
  400  EQRES=-ASMAX+TYS                                               CORE    70
       GO TO 440                                                      CORE    71
  410  IF(ASMIN.GE.-TYS) GO TO 430                                    CORE    72
  420  EQRES=-ASMIN-TYS                                               CORE    73
       GO TO 440                                                      CORE    74
  430  EQRES=0.                                                       CORE    75
  440  DIF=RES(I)-EQRES                                               CORE    76
  C                                                                   CORE    77
  C      CALCULATE RELAXATION FUNCTION                                CORE    78
  C                                                                   CORE    79
       ABMAX=ABS(ASMAX)                                               CORE    80
       ABMIN=ABS(ASMIN)                                               CORE    81
       ABMEAN=ABS(ASMEAN)                                             CORE    82
        IF(ABMAX.LT.1.)ABMAX=1.                                       CORE    83
        IF(ABMEAN.LT.1.)ABMEAN=0.5                                    CORE    84
       IF(ABMIN-ABMAX) 444,444,442                                    CORE    85
  442  ABM=ABMIN                                                      CORE    86
       GO TO 446                                                      CORE    87
  444  ABM=ABMAX                                                      CORE    88
  446  ENEP=C1/(ABM**E1*ABMEAN**E2)                                   CORE    89
       IF(IPRINT.GE.3)GO TO 351                                       CORE    90
       WRITE(6,350) STMAX(J),STMIN(J),SIGMAX(IRAIN),SIGMIN(IRAIN),    CORE    91
      *RES(J),EQRES,ENN(J),ENEP,J,IRAIN                               CORE    92
  350  FORMAT(6(F7.2,1X),F6.2,1X,E15.8,5X,I6,4X,I6)                   STD      1
  351     CONTINUE                                                    CORE    94
  C                                                                   CORE    95
  C       CALCULATE RESIDUAL STRESS RELAXATION                        CORE    96
  C                                                                   CORE    97
       IRAIN=IRAIN+1                                                  CORE    98
       ABDIF=ABS(DIF)                                                 CORE    99
       GO TO 360                                                      CORE   100
       GO TO 560                                                      CORE   101
  360  IF(ABDIF.LT.5.) GO TO 560                                      CORE   102
  370  IF(1000.*ENN(J).LT.ENEP) GO TO 560                             CORE   103
        IF(ENN(J).LE.10.) GO TO 560                                   CORE   104
  380  NFLAG=0                                                        CORE   105
       NFLAG2=10                                                      CORE   106
       IRAIN=IRAIN-1                                                  CORE   107
       DUMMY=ENN(J)                                                   CORE   108
  450  IF(DUMMY-ENEP) 470,460,460                                     CORE   109
  460  DUMMY=DUMMY/2.                                                 CORE   110
       NFLAG=NFLAG+1                                                  CORE   111
```

```
      GO TO 450
  470 CYCINT=DUMMY/10.
      DO 500 K=1,10
      DECK=FLOAT(K)
      EN(K)=CYCINT*DECK
      IF(K.EQ.1) GO TO 490
  480 EX(K)=EXP(-2.303*EN(K-1)/ENEP)+EXP(-2.303*EN(K)/ENEP)
      GO TO 500
  490 EX(K)=1.+EXP(-2.303*EN(K)/ENEP)
  500 CONTINUE
      IF(NFLAG.EQ.0) GO TO 530
  510 NFLAG2=NFLAG+10
      DO 520 K=11,NFLAG2
      EN(K)=2.*DUMMY
      EX(K)=EXP(-2.303*EN(K-1)/ENEP)+EXP(-2.303*EN(K)/ENEP)
      DUMMY=2.*DUMMY
  520 CONTINUE
  530 DO 559 K=1,NFLAG2
      SIGMAX(IRAIN)=ASMAX+EQRES+DIF*EX(K)/2.
      SIGMIN(IRAIN)=SIGMAX(IRAIN)-ASMAX+ASMIN
      RNCYC(IRAIN)=EN(K)
  545 IF(K.EQ.1) GO TO 540
  539 RNCYC(IRAIN)=RNCYC(IRAIN)-EN(K-1)
  540 IF(IPRINT.GE.3)GO TO 551
      WRITE(6,550)SIGMAX(IRAIN),SIGMIN(IRAIN),RNCYC(IRAIN),IRAIN
  550 FORMAT(16H RELAXATION     ,2(F7.2,1X),16X,F6.2,31X,I6)
  551  CONTINUE
      IRAIN=IRAIN+1
  559  CONTINUE
  560 CONTINUE
      RES(I)=EQRES+DIF*EXP(-2.303*ENN(J)/ENEP)
  570 CONTINUE
  569 RES(1)=RES(J)
      IN=IRAIN-1
C
C     *****************************************************************
C
C                              MODULE III
C                      CYCLE COUNTING TECHNIQUE
C
C     *****************************************************************
C
C       CALL SUBROUTINE TO RANGE PAIR COUNT SPECTRUM
C
       IF(IRPCM.GT.1)GO TO 591
      CALL RPCM(IN)
      GO TO 592
  591 CONTINUE
      KPMAX=IN
  592 CONTINUE
C
C     *****************************************************************
C
C                              MODULE IV
C                     DAMAGE ACCUMULATION CALCULATION
```

```
C
C     ***************************************************************
C
      IF(IPRINT.GE.3)GO TO 552
      WRITE(6,53)
   53 FORMAT(//60H LOCAL STRESSES AND PLASTIC STRAINS W/RESULTING FATIGU
     *E LIFE//10X,4HSTEP,10X,14HPLASTIC STRAIN,10X,10HMAX OR MIN,15X,6HD
     *AMAGE)
  552  CONTINUE
C
C       CALCULATE DAMAGE FROM PLASTIC STRAIN CYCLES
C
      SUMDEL=0.
      DO 531 JKL=1,NLEVEL
      AA=1.
      IF(PLSTRA(JKL)) 532,531,533
  532 AA=-1.
  533 PLSTRA(JKL)=AA*PLSTRA(JKL)
      CYCLES=(PLSTRA(JKL)/EPSD)**COFMAN
      DAM=1./CYCLES
      SUMNC=SUMNC+DAM
      SUMDEL=SUMDEL+DAM
      IF(IPRINT.GE.3) GO TO 531
      IF (AA) 535,535,537
  535 WRITE(6,199)JKL,PLSTRA(JKL),DAM
  199 FORMAT(10X,I4,12X,F10.5,15X,3HMIN,15X,E14.6)
       GO TO 531
  537 WRITE(6,219)JKL,PLSTRA(JKL),DAM
  219 FORMAT(10X,I4,12X,F10.5,15X,3HMAX,15X,E14.6)
  531 CONTINUE
      WRITE(6,541) SUMDEL
  541 FORMAT(63X,29H DAMAGE FROM PLASTIC STRAINS=,E15.8)
      IF(IPRINT.GE.3) GO TO 536
      WRITE(6,13)
   13 FORMAT(/16X,15H SIGMAX  SIGMIN,18X,6H RNCYC,20X,25H CYCLES
     *   ENN/CYC)
  536 CONTINUE
C
C       CALCULATE ELASTIC CYCLE DAMAGE FROM LEAST SQUARE FITTED S-N DATA
C         (MODIFIED GOODMAN DIAGRAM FORMAT)
C
      DO 600 JKL=1,KPMAX
  534 TTYS=TYS/5.
      IF(SIGMAX(JKL)-SIGMIN(JKL).LT.1.6*TYS)GO TO 310
      CYCLES=10.**4.
      GO TO 340
  310 IF(SIGMAX(JKL).GE.TTYS)GO TO 320
  447 CYCLES=10.**9.
       GO TO 340
  320 N=4
      DO 330 M=1,4
      R(N)=A(N)*SIGMIN(JKL)**2+B(N)*SIGMIN(JKL)+C(N)-SIGMAX(JKL)
      N=N+1
  330 CONTINUE
  332 IF(R(7)*R(4)) 338,338,334
```

```
 334  ABR7=ABS(R(7))
      ABR4=ABS(R(4))
      IF(ABR7.LE.ABR4 ) GO TO 336
 335  EXPO=4.+R(4)/(R(4)-R(5))
      GO TO 339
 336  EXPO=7.+R(7)/(R(6)-R(7))
      GO TO 339
 338  SUMR=R(4)+R(5)+R(6)+R(7)
      SUMR2=R(4)**2+R(5)**2+R(6)**2+R(7)**2
      SUMR3=R(4)**3+R(5)**3+R(6)**3+R(7)**3
      SUMR4=R(4)**4+R(5)**4+R(6)**4+R(7)**4
      SUMRN=4.*R(4)+5.*R(5)+6.*R(6)+7.*R(7)
      SUMR2N=4.*R(4)**2+5.*R(5)**2+6.*R(6)**2+7.*R(7)**2
      DEL1=4.*SUMR2*SUMR4-4.*SUMR3**2
      DEL2=SUMR*SUMR2*SUMR3-SUMR4*SUMR**2
      DEL3=SUMR*SUMR2*SUMR3-SUMR2**3
      D01=22.*SUMR2*SUMR4-22.*SUMR3**2
      D02=SUMR2*SUMR3*SUMRN-SUMR*SUMR4*SUMRN
      D03=SUMR*SUMR3*SUMR2N-SUMR2N*SUMR2**2
      EXPO=(D01+D02+D03)/(DEL1+DEL2+DEL3)
 339  CYCLES=10.**EXPO
      IF(EXPO.LE.4.)CYCLES=10.**4.
 340  ENNCYC=RNCYC(JKL)/CYCLES
      SUMNC=SUMNC+ENNCYC
      SUMDEL=SUMDEL+ENNCYC
      IF(IPRINT.GE.3)GO TO 600
      WRITE(6,599) SIGMAX(JKL),SIGMIN(JKL),RNCYC(JKL),CYCLES,ENNCYC
 599   FORMAT(16X,2(F7.2,1X),16X,F6.0,17X,2(E15.8,1X))
 600  CONTINUE
      WRITE(6,593) SUMDEL
 593  FORMAT(/69X,21H DAMAGE PER THIS SET=,E15.8)
      WRITE(6,575)  SUMNC
 575  FORMAT(/69X,18H  TOTAL ENN/CYC =,E15.8)
      END
```

```
      SUBROUTINE RPCM(NPKS)                                             CORE   256
C                                                                       CORE   257
C     THIS PROGRAM EMPLOYS THE RANGE PAIR CYCLE COUNTING METHOD TO GENER CORE   258
C     ANALYSIS SPECTRUM FROM A GIVEN LOAD SPECTRUM                      CORE   259
C                                                                       CORE   260
C                                                                       CORE   261
C                              PROGRAM ARRAYS                           CORE   262
C                 (INFORMATION NEEDED TO CHANGE DIMENSIONS)             CORE   263
C                                                                       CORE   264
C     ARRAY NAME             DEFINITION                     DIMENSION   CORE   265
C       SIGMAX    PEAKS OF THE INPUT LOAD SPECTRUM          NPKS + KK   CORE   266
C             KK = THE NUMBER OF ADDITIONAL CYCLES (EXCLUDING INPUT CYCL CORE   267
C                 WHICH THE PROGRAM WILL GENERATE                       CORE   268
C       SIGMIN    VALLEYS OF THE INPUT LOAD SPECTRUM        NPKS + KK   CORE   269
C       RNCYC     K COUNTERS OF THE PEAKS AND VALLEYS       NPKS + KK   CORE   270
C       NSTEP     STEP NUMBERS OF THE INPUT SPECTRUM        NPKS + KK   CORE   271
C       RES       RESIDUE SPECTRUM                           2*NPKS     CORE   272
C       INDEX     STEP NUMBERS OF ELEMENTS IN RES            2*NPKS     CORE   273
C       CYCLE     RANGE PAIR COUNTED CYCLES                 NPKS + KK   CORE   274
C       RNECYC    K COUNTERS OF THE CYCLES OF THE           NPKS + KK   CORE   275
C                 UNSORTED ANALYSIS SPECTRUM                            CORE   276
C       NNSTEP    STEP NUMBERS OF ELEMENTS OF THE           NPKS + KK   CORE   277
C                 UNSORTED ANALYSIS SPECTRUM                            CORE   278
C       ISAVE     VALUES OF NSTEP(J) SUCH THAT RNCYC(J)        99       CORE   279
C                 IS < 1.0 AND VALUES OF NSTEP(J) SUCH                  CORE   280
C                 THAT SIGMAX(J-1) = SIGMAX(J) AND                      CORE   281
C                 SIGMIN(J-1) = SIGMIN(J)                               CORE   282
C                                                                       CORE   283
C                                                                       CORE   284
      COMMON/MSAL/RNCYC(200),KPMAX,IPRINT                               CORE   285
      COMMON/MDEC1/SIGMAX(200),SIGMIN(200)                              CORE   286
      COMMON/MDEC2/NSTEP(200),LR,KMAX,KMIN,K31                          CORE   287
      COMMON/MDECR/RES(450),INDEX(450),IND1,IND2,IND3,IND4,KIND         CORE   288
      COMMON/MCYG/CYCLE(200,2),RNECYC(200),NNSTEP(200)                  CORE   289
      COMMON/MCGDE/L,LIND                                               CORE   290
      DIMENSION ISAVE(99),TITLE(8)                                      CORE   291
 9999 NPUNCH = 0                                                        CORE   292
      DO 8000 I = 1,NPKS                                                CORE   293
 8000 NSTEP(I) = I                                                      CORE   294
      IF(IPRINT.GE.2)GO TO 103                                          CORE   295
      WRITE(6,20) NPKS                                                  CORE   296
   20 FORMAT(1H0,60HTHE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPE CORE   297
     1CTRUM = ,I5//)                                                    CORE   298
      WRITE(6,22)                                                       CORE   299
   22 FORMAT(60X,5HSIGMA/31X,4HSTEP,13X,7HMAXIMUM,16X,7HMINIMUM,13X,    CORE   300
     1       9HCOUNTER K/)                                              CORE   301
      WRITE(6,25) (NSTEP(I),SIGMAX(I),SIGMIN(I),RNCYC(I), I = 1,NPKS)   CORE   302
   25 FORMAT(29X,I5,10X,E13.6,10X,E13.6,10X,F10.5)                      CORE   303
  103   CONTINUE                                                        CORE   304
C                                                                       CORE   305
C     SORT THROUGH THE LOAD SPECTRUM - PULL OUT THOSE PEAKS AND VALLEYS CORE   306
C     COUNTER K IS LESS THAN 1.0                                        CORE   307
C                                                                       CORE   308
      J = 1                                                             CORE   309
      L = 0                                                             CORE   310
```

```
      NRES = 1
      NCYNO = 100
      JMAX = 0
      DO 100 I = 1,NPKS
      IF (RNCYC(I) .GE. 1.0) GO TO 100
      X1 = SIGMAX(I)
      X2 = SIGMIN(I)
      CALL CYCGEN(X1,X2  ,RNCYC(I),NSTEP(I))
      ISAVE(J) = I
      J = J + 1
  100 CONTINUE
      JMAX = J - 1
      NPKSN = NPKS - JMAX
      IF (JMAX .EQ. 0) GO TO 200
      WRITE(6,23) (ISAVE(K), K = 1,JMAX)
      IF(IPRINT.GE.2)GO TO 101
   23 FORMAT(1H0,93HSTEP NUMBERS OF THOSE PEAKS AND VALLEYS IN THE LOAD
     1SPECTRUM WHOSE COUNTER K IS LESS THAN 1.0//(17I7))
101   CONTINUE
      DO 110 J = 1,JMAX
      I = ISAVE(J) - (J-1)
      NPKN = NPKS - J
      IF (I .EQ. NPKN) GO TO 110
      DO 115 II = I,NPKN
      SIGMAX(II) = SIGMAX(II+1)
      SIGMIN(II) = SIGMIN(II+1)
      NSTEP(II) = NSTEP(II+1)
      RNCYC(II) = RNCYC(II+1)
  115 CONTINUE
  110 CONTINUE
  200 CONTINUE
C
C     SORT THROUGH THE LOAD SPECTRUM DATA - COMBINE STEPS WITH IDENTICAL
C     AND VALLEYS WHICH OCCUR CONSECUTIVELY
C
      J = 1
      DO 300 I = 2,NPKSN
      IF (SIGMAX(I) .NE. SIGMAX(I-1)) GO TO 300
      IF (SIGMIN(I) .NE. SIGMIN(I-1)) GO TO 300
      ISAVE(J) = I
      RNCYC(I-1) = RNCYC(I-1) + RNCYC(I)
      J = J + 1
  300 CONTINUE
      IF (J .EQ. 1) GO TO 6000
      JMAS = J - 1
      DO 311 J = 1,JMAS
      I = ISAVE(J) - (J-1)
      NPKN = NPKSN - J
      IF (I .EQ. NPKN) GO TO 311
      DO 316 II = I,NPKN
      SIGMAX(II) = SIGMAX(II+1)
      SIGMIN(II) = SIGMIN(II+1)
      NSTEP(II) = NSTEP(II+1)
      RNCYC(II) = RNCYC(II+1)
  316 CONTINUE
```

```
  311 CONTINUE
      NPKSN = NPKSN - JMAS
C
C     RANGE PAIR COUNT THE ADJUSTED LOAD SPECTRUM
C
 6000 I = 1
      KB = 0
      L = JMAX
      KMIN = 0
      KMAX = 0
      LR = 0
      K31 = 0
    1 IF (RNCYC(I) .GT. 1.0) GO TO 400
      IF (KB .NE. 0) GO TO 5
      X1 = SIGMAX(I)
      X2 = SIGMIN(I)
      IND1 = NSTEP(I)
      IND2 = IND1
      I = I + 1
      KB = 1
      GO TO 1
    5 X3 = SIGMAX(I)
      X4 = SIGMIN(I)
      IND3 = NSTEP(I)
      IND4 = IND3
      KMIN = 1
      KMAX = 0
      K31 = 0
      IF (RNCYC(I) .EQ. 1.0) GO TO 6
      KEY = 1
      KIND = 1
      GO TO 415
    6 KEY = 0
       CYCNO = AINT(RNCYC(I)+0.5)
      CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)
 1000 GO TO (10,10,30),KCYGEN
   10 KB = 1
      I = I + 1
      IF (KMIN .NE. 1) GO TO 36
      IF (I .LE. NPKSN) GO TO 5
      RES(LR+1) = X1
      RES(LR+2) = X2
      INDEX(LR+1) = IND1
      INDEX(LR+2) = IND2
      LRMAX = LR + 2
      GO TO 2000
   30 IF (KMIN .NE. 1) GO TO 35
   12 I = I + 1
      IF (I .LE. NPKSN) GO TO 31
      RES(LR+1) = X1
      RES(LR+2) = X2
      RES(LR+3) = X3
      INDEX(LR+1) = IND1
      INDEX(LR+2) = IND2
      INDEX(LR+3) = IND3
```

```
      LRMAX = LR + 3                                              CORE    421
      GO TO 2000                                                  CORE    422
 31   X4 = SIGMAX(I)                                              CORE    423
      IND4 = NSTEP(I)                                             CORE    424
      KMAX = 1                                                    CORE    425
      KMIN = 0                                                    CORE    426
      K31 = 1                                                     CORE    427
   32 IF (RNCYC(I) .GT. 1.0) GO TO 40                             CORE    428
      GO TO 6                                                     CORE    429
   40 KEY = 1                                                     CORE    430
      KIND = 0                                                    CORE    431
      GO TO 415                                                   CORE    432
   35 X4 = SIGMIN(I)                                              CORE    433
      IND4 = NSTEP(I)                                             CORE    434
      KMIN = 1                                                    CORE    435
      KMAX = 0                                                    CORE    436
      K31 = 0                                                     CORE    437
      GO TO 32                                                    CORE    438
   36 X3 = SIGMIN(I)                                              CORE    439
      IND3 = NSTEP(I)                                             CORE    440
      KMIN = 1                                                    CORE    441
      KMAX = 0                                                    CORE    442
      GO TO 12                                                    CORE    443
  400 KEY = 1                                                     CORE    444
      IF (KB .NE. 0) GO TO 410                                    CORE    445
      X1 = SIGMAX(I)                                              CORE    446
      X2 = SIGMIN(I)                                              CORE    447
      X3 = SIGMAX(I)                                              CORE    448
      X4 = SIGMIN(I)                                              CORE    449
      IND1 = NSTEP(I)                                             CORE    450
      IND2 = IND1                                                 CORE    451
      IND3 = IND1                                                 CORE    452
      IND4 = IND1                                                 CORE    453
      KMIN = 1                                                    CORE    454
      KMAX = 0                                                    CORE    455
      K31 = 0                                                     CORE    456
      IF (RNCYC(I) .LE. 2.0) GO TO 401                            CORE    457
      RNCYC(I) = RNCYC(I) - 1.0                                   CORE    458
      GO TO 402                                                   CORE    459
  401 RNCYC(I) = RNCYC(I) - 2.0                                   CORE    460
  402 KIND = 0                                                    CORE    461
      GO TO 415                                                   CORE    462
  410 X3 = SIGMAX(I)                                              CORE    463
      X4 = SIGMIN(I)                                              CORE    464
      IND3 = NSTEP(I)                                             CORE    465
      IND4 = IND3                                                 CORE    466
      KMIN = 1                                                    CORE    467
      KMAX = 0                                                    CORE    468
      K31 = 0                                                     CORE    469
      KIND = 1                                                    CORE    470
      RNCYC(I) = RNCYC(I) - 1.0                                   CORE    471
      KB = 0                                                      CORE    472
 415   CYCNO = AINT(RNCYC(I)+0.5)                                 CORE    473
      CALL DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)                 CORE    474
      GO TO 1000                                                  CORE    475
```

```
 2000 LMAX = L                                                          CORE    476
      IF (LRMAX .LT. 4) GO TO 5000                                      CORE    477
      IF (NCYNO .EQ. 0) GO TO 5000                                      CORE    478
C                                                                       CORE    479
C     RANGE PAIR COUNT OF RESIDUE SPECTRUMS                             CORE    480
C                                                                       CORE    481
      NRES = NRES + 1                                                   CORE    482
      CALL DECRES(LRMAX,NCYNO)                                          CORE    483
      GO TO 2000                                                        CORE    484
 5000 IF (LRMAX .LE. 1) GO TO 3000                                      CORE    485
C                                                                       CORE    486
C     COUNT THE LAST RESIDUE SPECTRUM - RANGE PAIR COUNTING WILL YIELD N CORE   487
C     ADDITIONAL CYCLES                                                 CORE    488
C                                                                       CORE    489
      KK = 0                                                            CORE    490
      RESMAX = RES(1)                                                   CORE    491
      RESMIN = RES(1)                                                   CORE    492
      IMAX = 1                                                          CORE    493
      IMIN = 1                                                          CORE    494
      DO 500 I = 2,LRMAX                                                CORE    495
      IF (RES(I) .LT. RESMAX) GO TO 490                                 CORE    496
      RESMAX = RES(I)                                                   CORE    497
      IMAX = I                                                          CORE    498
      GO TO 500                                                         CORE    499
  490 IF (RES(I) .GT. RESMIN) GO TO 500                                 CORE    500
      RESMIN = RES(I)                                                   CORE    501
      IMIN = I                                                          CORE    502
500   CONTINUE                                                          CORE    503
      CALL CYCRES(RESMAX,RESMIN,1.0,INDEX(IMAX))                        CORE    504
      KK = KK + 1                                                       CORE    505
  510 J = IMAX - 2                                                      CORE    506
      IF (J .LE. 0) GO TO 550                                           CORE    507
      CALL CYCRES(RES(J),RES(J+1),1.0,INDEX(J))                         CORE    508
      KK = KK + 1                                                       CORE    509
      IMAX = J                                                          CORE    510
      GO TO 510                                                         CORE    511
  550 J = IMIN + 2                                                      CORE    512
      IF (J .GT. LRMAX) GO TO 575                                       CORE    513
      CALL CYCRES(RES(J-1),RES(J),1.0,INDEX(J-1))                       CORE    514
      KK = KK + 1                                                       CORE    515
      IMIN = J                                                          CORE    516
      GO TO 550                                                         CORE    517
575   KMAX = KK                                                         CORE    518
      LMAX = L                                                          CORE    519
C                                                                       CORE    520
C     SORT THE ANALYSIS SPECTRUM TO PRODUCE THE RANGE PAIR COUNTED SPECT CORE   521
C                                                                       CORE    522
 3000 KP = 0                                                            CORE    523
      DO 605 JJ = 1,NPKS                                                CORE    524
      KC = 0                                                            CORE    525
      DO 600 I = 1,LMAX                                                 CORE    526
      IF (NNSTEP(I) .NE. JJ) GO TO 600                                  CORE    527
      KP = KP + 1                                                       CORE    528
      KC = KC + 1                                                       CORE    529
      NSTEP(KP) = KP                                                    CORE    530
```

```
      SIGMAX(KP) = CYCLE(I,1)                                           CORE   531
      SIGMIN(KP) = CYCLE(I,2)                                           CORE   532
      RNCYC(KP) = RNECYC(I)                                             CORE   533
      IF (KC .LT. 2) GO TO 600                                          CORE   534
      IF (SIGMAX(KP) .NE. SIGMAX(KP-1)) GO TO 600                       CORE   535
      IF (SIGMIN(KP) .NE. SIGMIN(KP-1)) GO TO 600                       CORE   536
  595 KP = KP - 1                                                       CORE   537
      RNCYC(KP) = RNCYC(KP) + 1.0                                       CORE   538
  600 CONTINUE                                                          CORE   539
  605 CONTINUE                                                          CORE   540
      KPMAX = KP                                                        CORE   541
      IF(IPRINT.GE.2)GO TO 104                                          CORE   542
      WRITE(6,2010)                                                     CORE   543
 2010 FORMAT(1H1,48X,33HRANGE PAIR CYCLE COUNTED SPECTRUM//)            CORE   544
      WRITE(6,22)                                                       CORE   545
      WRITE(6,25)  (NSTEP(I),SIGMAX(I),SIGMIN(I),RNCYC(I),I = 1,KPMAX)  CORE   546
  102 FORMAT(5X,3F10.2)                                                 CORE   547
 104  CONTINUE                                                          CORE   548
      END                                                               CORE   549
```

```
      SUBROUTINE CYCGEN(Y1,Y2,  CYCPF,NSTEPP)                            CORE     550
      COMMON/MCYG/CYCLE(200,2),RNECYC(200),NNSTEP(200)                   CORE     551
      COMMON/MCGDE/L,LIND                                                CORE     552
C                                                                        CORE     553
C     THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DA CORE     554
C     SUPPLIED BY SUBROUTINE DECIDE                                      CORE     555
C                                                                        CORE     556
      LIND = 0                                                           CORE     557
      L = L + 1                                                          CORE     558
      CYCLE(L,1) = Y1                                                    CORE     559
      CYCLE(L,2) = Y2                                                    CORE     560
      RNECYC(L) = CYCPF                                                  CORE     561
      NNSTEP(L) = NSTEPP                                                 CORE     562
      IF (L .EQ. 1) GO TO 100                                            CORE     563
      IF (CYCLE(L-1,1) .NE. CYCLE(L,1)) GO TO 100                        CORE     564
      IF (CYCLE(L-1,2) .NE. CYCLE(L,2)) GO TO 100                        CORE     565
   10 L = L - 1                                                          CORE     566
      RNECYC(L) = RNECYC(L) + 1.0                                        CORE     567
      LIND = 1                                                           CORE     568
  100 RETURN                                                             CORE     569
      END                                                                CORE     570
```

```
      SUBROUTINE DECIDE(X1,X2,X3,X4,KEY,I,CYCNO,KCYGEN)                 CORE 571
      COMMON/MDEC1/SIGMAX(200),SIGMIN(200)                              CORE 572
      COMMON/MDEC2/NSTEP(200),LR,KMAX,KMIN,K31                          CORE 573
      COMMON/MDECR/RES(450),INDEX(450),IND1,IND2,IND3,IND4,KIND         CORE 574
      COMMON/MCYG/CYCLE(200,2),RNECYC(200),NNSTEP(200)                  CORE 575
      COMMON/MCGDE/L,LIND                                               CORE 576
C                                                                       CORE 577
C     THIS SUBROUTINE DECIDES WHETHER OR NOT THE VALUES X1,X2,X3, AND X4 CORE 578
C     FROM THE ADJUSTED LOAD SPECTRUM SATISFY THE RANGE PAIR COUNTING CO CORE 579
C                                                                       CORE 580
      KFIRST = 0                                                        CORE 581
      IF (K31 .NE. 0) GO TO 11                                          CORE 582
   10 IF (X3 .LE. X2) GO TO 200                                         CORE 583
   11 IF (X2 .GT. X1) GO TO 210                                         CORE 584
      IF (X2 .LT. X4 .OR. X3 .GT. X1) GO TO 500                         CORE 585
  150 IF (X2 .GT. X3) GO TO 151                                         CORE 586
      CALL CYCGEN(X3,X2,1.0,NSTEP(I))                                   CORE 587
      GO TO 152                                                         CORE 588
  151 CALL CYCGEN(X2,X3,  1.0,NSTEP(I))                                 CORE 589
  152 X1 = X1                                                           CORE 590
      X2 = X4                                                           CORE 591
      IF (IND3 .NE. IND2) LIND = 1                                      CORE 592
      IND2 = IND4                                                       CORE 593
      KCYGEN = 1                                                        CORE 594
      IF (KEY .NE. 0) GO TO 110                                         CORE 595
      RETURN                                                            CORE 596
  210 IF (X2 .GT. X4 .OR. X3 .LT. X1) GO TO 500                         CORE 597
      GO TO 150                                                         CORE 598
  200 X1 = X1                                                           CORE 599
      X2 = X4                                                           CORE 600
      IND2 = IND4                                                       CORE 601
      KCYGEN = 2                                                        CORE 602
      IF (KEY .EQ. 0) RETURN                                            CORE 603
      CYCNO = CYCNO - 1.0                                               CORE 604
      GO TO 110                                                         CORE 605
C                                                                       CORE 606
C     ADD X1 TO THE RESIDUE SPECTRUM                                    CORE 607
C                                                                       CORE 608
  500 LR = LR + 1                                                       CORE 609
      RES(LR) = X1                                                      CORE 610
      INDEX(LR) = IND1                                                  CORE 611
      X1 = X2                                                           CORE 612
      X2 = X3                                                           CORE 613
      X3 = X4                                                           CORE 614
      IND1 = IND2                                                       CORE 615
      IND2 = IND3                                                       CORE 616
      IND3 = IND4                                                       CORE 617
      KCYGEN = 3                                                        CORE 618
      IF (KEY .NE. 0) GO TO 110                                         CORE 619
      RETURN                                                            CORE 620
  110 GO TO (1150,1200,1500),KCYGEN                                     CORE 621
 1150 IF (CYCNO .GT. 1.0) GO TO 1151                                    CORE 622
      IF(CYCNO .LE. 0.0) RETURN                                         CORE 623
 1153 CYCNO = CYCNO - 1.0                                               CORE 624
      GO TO 1152                                                        CORE 625
```

```
      1151 IF (LIND .EQ. 1) GO TO 1153                                  CORE    626
           IF (IND3 .NE. IND4) GO TO 1153                               CORE    627
           RNECYC(L) = RNECYC(L) + CYCNO - 2.0                          CORE    628
           CYCNO = 1.0                                                  CORE    629
      1152 IF (KMAX .NE. 1) GO TO 111                                   CORE    630
           X3 = SIGMIN(I)                                               CORE    631
           IND3 = NSTEP(I)                                              CORE    632
           IF (CYCNO .GT.0.0) GO TO 112                                 CORE    633
           KMIN = 1                                                     CORE    634
           KMAX = 0                                                     CORE    635
           KCYGEN = 3                                                   CORE    636
           RETURN                                                       CORE    637
     1200  IF(CYCNO .LE. 0.0) RETURN                                    CORE    638
           CYCNO = CYCNO - 1.0                                          CORE    639
           X3 = SIGMAX(I)                                               CORE    640
           X4 = SIGMIN(I)                                               CORE    641
           KFIRST = 1                                                   CORE    642
           GO TO 113                                                    CORE    643
       111 X3 = SIGMAX(I)                                               CORE    644
           X4 = SIGMIN(I)                                               CORE    645
           IF (KFIRST .NE. 0) GO TO 113                                 CORE    646
           CYCNO = CYCNO - 1.0                                          CORE    647
           KFIRST = 1                                                   CORE    648
       113 IND3 = NSTEP(I)                                              CORE    649
           IND4 = IND3                                                  CORE    650
           KMIN = 1                                                     CORE    651
           KMAX = 0                                                     CORE    652
           GO TO 10                                                     CORE    653
      1500 IF (KMAX .NE. 0) GO TO 1510                                  CORE    654
           IF(CYCNO .LE. 0.0) RETURN                                    CORE    655
           CYCNO = CYCNO - 1.0                                          CORE    656
       112 X4 = SIGMAX (I)                                              CORE    657
           IND4 = NSTEP(I)                                              CORE    658
           KMAX = 1                                                     CORE    659
           KMIN = 0                                                     CORE    660
           GO TO 11                                                     CORE    661
      1510 X4 = SIGMIN(I)                                               CORE    662
           IND4 = NSTEP(I)                                              CORE    663
           KMAX = 0                                                     CORE    664
           KMIN = 1                                                     CORE    665
           GO TO 10                                                     CORE    666
           END                                                          CORE    667
```

```
          SUBROUTINE DECRES(LRMAX,NCYNO)                                   CORE     668
          COMMON/MCGDE/L,LIND                                              CORE     669
          COMMON/MDECR/RES(450),INDEX(450),IND1,IND2,IND3,IND4,KIND        CORE     670
C                                                                          CORE     671
C         THIS SUBROUTINE DECIDES WHETHER OR NOT THE ELEMENTS OF THE RESIDUE CORE   672
C         SPECTRUM SATISFY THE RANGE PAIR COUNTING CONDITIONS              CORE     673
C                                                                          CORE     674
          K = 0                                                            CORE     675
          NCYNO = 0                                                        CORE     676
          X1 = RES(1)                                                      CORE     677
          X2 = RES(2)                                                      CORE     678
          X3 = RES(3)                                                      CORE     679
          X4 = RES(4)                                                      CORE     680
          IND1 = INDEX(1)                                                  CORE     681
          IND2 = INDEX(2)                                                  CORE     682
          IND3 = INDEX(3)                                                  CORE     683
          IND4 = INDEX(4)                                                  CORE     684
          J = 4                                                            CORE     685
       10 IF (X2 .GT. X1) GO TO 100                                        CORE     686
          IF (X2 .LT. X4 .OR. X3 .GT. X1) GO TO 500                        CORE     687
      150 IF (X2 .GT. X3) GO TO 151                                        CORE     688
          CALL CYCRES(X3,X2,1.0,IND3)                                      CORE     689
          GO TO 152                                                        CORE     690
      151 CALL CYCRES(X2,X3,1.0,IND2)                                      CORE     691
      152 NCYNO = NCYNO + 1                                                CORE     692
          X1 = X1                                                          CORE     693
          X2 = X4                                                          CORE     694
          IND2 = IND4                                                      CORE     695
          IF (J .EQ. LRMAX) GO TO 300                                      CORE     696
          IF ((J + 1) .EQ. LRMAX) GO TO 315                                CORE     697
          X3 = RES(J+1)                                                    CORE     698
          X4 = RES(J+2)                                                    CORE     699
          IND3 = INDEX(J+1)                                                CORE     700
          IND4 = INDEX(J+2)                                                CORE     701
          J = J+2                                                          CORE     702
          GO TO 10                                                         CORE     703
      100 IF (X2 .GT. X4 .OR. X3 .LT. X1) GO TO 500                        CORE     704
          GO TO 150                                                        CORE     705
      500 K = K + 1                                                        CORE     706
          RES(K) = X1                                                      CORE     707
          INDEX(K) = IND1                                                  CORE     708
          J = J + 1                                                        CORE     709
          IF (J .GT. LRMAX) GO TO 330                                      CORE     710
          X1 = X2                                                          CORE     711
          X2 = X3                                                          CORE     712
          X3 = X4                                                          CORE     713
          X4 = RES(J)                                                      CORE     714
          IND1 = IND2                                                      CORE     715
          IND2 = IND3                                                      CORE     716
          IND3 = IND4                                                      CORE     717
          IND4 = INDEX(J)                                                  CORE     718
          GO TO 10                                                         CORE     719
      300 K = K + 1                                                        CORE     720
          RES(K) = X1                                                      CORE     721
          RES(K+1) = X2                                                    CORE     722
```

```
      INDEX(K) = IND1
      INDEX(K+1) = IND2
      LRMAX = K + 1
      RETURN
  315 K = K + 1
      RES(K) = X1
      RES(K+1) = X2
      RES(K+2) = RES(J+1)
      INDEX(K) = IND1
      INDEX(K+1) = IND2
      INDEX(K+2) = INDEX(J+1)
      LRMAX = K + 2
      RETURN
  330 K = K + 1
      RES(K) = X2
      RES(K+1) = X3
      RES(K+2) = X4
      INDEX(K) = IND2
      INDEX(K+1) = IND3
      INDEX(K+2) = IND4
      LRMAX = K + 2
      RETURN
      END
```

```
      SUBROUTINE CYCRES(Y1,Y2,  CYCPF,NSTEPP)                        CORE      746
      COMMON/MCYG/CYCLE(200,2),RNECYC(200),NNSTEP(200)               CORE      747
      COMMON/MCGDE/L,LIND                                            CORE      748
C                                                                    CORE      749
C     THIS SUBROUTINE GENERATES CYCLES FOR THE ANALYSIS SPECTRUM FROM DA CORE  750
C     SUPPLIED BY SUBROUTINE DECRES                                  CORE      751
C                                                                    CORE      752
      L = L + 1                                                      CORE      753
      CYCLE(L,1) = Y1                                                CORE      754
      CYCLE(L,2) = Y2                                                CORE      755
      RNECYC(L) = CYCPF                                              CORE      756
      NNSTEP(L) = NSTEPP                                             CORE      757
      RETURN                                                         CORE      758
      END                                                            CORE      759
```

APPENDIX II

SAMPLE PROBLEM WITH INPUT DATA LISTING

```
1 DATA DECKS ARE TO BE PROCESSED.

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
SEQUENCE ACCOUNTABLE FATIGUE EVALUATION
```

```
SPECTRUM FROM     B-1 SPECTRUM  --  TRUNCATION LEVEL  270,000 CYCLES
MATERIAL TYPE --  2219-T851 AL

TENSILE YIELD STRESS (KSI) --          55.00000

LCF STRAIN INTERCEPT =            .40000

INVERSE OF COFFIN-MANSON SLOPE          -1.83600

ELASTIC MODULUS =        10000.00000

COEFFICIENTS OF SECOND ORDER LEAST SQUARE FIT OF S-N DATA
     SMAX = A(I)*SMIN**2 + B(I)*SMIN + C(I)
     LIFE              A(I)                 B(I)                C(I)
   10** 4            -.00217               .22041             55.82462
   10** 5            -.00178               .33210             48.26657
   10** 6            -.00149               .46283             39.66455
   10** 7            -.00243               .64199             31.70955

UNNOTCHED COUPON S-N DATA DERIVED FROM
INFORMATION SUPPLIED FROM  NORTH AMERICAN

RESIDUAL STRESS RELAXATION FUNCTION

     ENEP = C1/(KTSMAX**E1 * KTSMEAN**E2)
WHERE   C1 =  .25000000E+07 ,   E1 =     1.000 AND  E2 =     1.000

        7 TIMES THROUGH BLOCK OF        44 LOADS

     LOAD LIMIT =           26.90000
```

STEP	TYPE	STMIN	STMAX	ENN
1	1	-.14800	-.02900	1.00000
2	3	.58400	1.00000	1.00000
3	2	.58400	.89500	1.00000
4	1	.58400	.68400	1.00000
5	1	.45500	.58400	1.00000
6	1	.64800	.69300	1.00000
7	1	.39500	.69900	1.00000
8	1	.48800	.56300	3.00000
9	1	.23500	.50900	1.00000
10	1	.50900	.62700	2.00000
11	1	.43400	.50900	1.00000
12	1	.36400	.69000	1.00000
13	1	.13300	.36400	1.00000
14	1	.36400	.48200	6.00000
15	1	.30400	.36400	1.00000
16	1	.30700	.75600	1.00000
17	1	.31600	.52700	1.00000
18	2	.54500	.70800	1.00000
19	1	.33400	.61700	1.00000
20	1	.40100	.51200	7.00000
21	1	.12700	.54800	1.00000
22	1	.22900	.37700	48.00000
23	1	-.00600	.34000	1.00000
24	1	.13000	.24400	35.00000
25	1	.07800	.72300	1.00000
26	1	.11100	.55700	9.00000
27	1	.18700	.37700	10.00000
28	3	.52700	.99100	1.00000

29	2	-.12000	.88300	1.00000
30	1	.52700	.74700	1.00000
31	1	-.14900	-.02900	1.00000
32	1	.55700	.84600	1.00000
33	1	.50900	.88000	1.00000
34	1	.33100	.52700	1.00000
35	1	.52700	.61700	19.00000
36	1	.46400	.52700	2.00000
37	1	.48200	.81000	1.00000
38	1	.58100	.68700	1.00000
39	1	.32200	.70200	1.00000
40	1	.39500	.44900	9.00000
41	1	.43100	.59000	5.00000
42	1	.46100	.54500	29.00000
43	1	-.14800	-.02900	1.00000
44	1	-.13600	-.03900	1.00000

BLOCK	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE
1	1	-0	-0					
2	1	-0	-0					
3	2	1	-0					
4	1	-0	-0					
5	3	1	-0					
6	1	-0	-0					
7	1	-0	-0					

SPECTRUM FROM B-1 SPECTRUM -- TRUNCATION LEVEL 270,000 CYCLES

AKT = 4.50

RELAXATION CONSTANT C1= 2500000.00

SPECTRUM SUBJECTED TO THE RANGE-PAIR COUNTING TECHNIQUE
FLIGHT OR BLOCK NO. 1

STMAX	STMIN	SIGMAX	SIGMIN	RES	EQRES	ENN	NEP		
-.78	-3.98	-3.51	-17.92	0.00	0.00	1.00	.13025831E+05	1	1
18.40	15.71	55.00	42.89	0.00	-27.80	1.00	.39342782E+03	2	2
15.71	12.24	42.89	27.28	-27.80	-15.69	1.00	.56235689E+03	3	3
18.64	17.43	55.00	49.55	-27.75	-28.89	1.00	.36717948E+03	4	4
16.80	10.63	55.00	18.20	-28.89	-29.61	1.00	.44621680E+03	5	5
15.14	13.13	38.54	29.46	-29.61	-13.15	3.00	.57657259E+03	6	6
13.69	6.32	32.20	-.97	-29.42	-6.61	1.00	.90105168E+03	7	7
16.87	13.69	46.54	32.25	-29.36	-20.90	2.00	.47906511E+03	8	8
13.69	11.67	32.34	23.26	-29.28	-6.61	1.00	.71090397E+03	9	9
15.56	9.79	54.32	14.86	-29.21	-28.52	1.00	.46919213E+03	10	10
9.79	3.58	14.86	-13.10	-29.20	0.00	1.00	.18861779E+04	11	11
12.97	9.79	29.18	14.90	-29.17	-3.35	6.00	.83680259E+03	12	12
9.79	8.18	15.32	8.06	-28.74	0.00	1.00	.14033389E+04	13	13
20.34	8.26	55.00	.65	-28.70	-36.51	1.00	.42460525E+03	14	14
14.18	8.50	27.28	1.74	-36.51	-8.79	1.00	.76807252E+03	15	15
16.60	8.98	38.26	4.00	-36.43	-19.69	1.00	.58153350E+03	16	16
13.77	10.79	25.61	12.18	-36.36	-6.98	7.00	.72996103E+03	17	17
14.74	3.42	30.61	-20.35	-35.72	-11.34	1.00	.92247814E+03	18	18
10.14	6.16	9.97	-7.94	-35.66	0.00	48.00	.14935730E+04	19	18
RELAXATION		10.11	-7.81			4.80			19
RELAXATION		10.37	-7.55			4.80			20
RELAXATION		10.63	-7.29			4.80			21
RELAXATION		10.89	-7.03			4.80			22
RELAXATION		11.14	-6.77			4.80			23
RELAXATION		11.40	-6.52			4.80			24
RELAXATION		11.65	-6.27			4.80			25
RELAXATION		11.90	-6.02			4.80			26
RELAXATION		12.15	-5.77			4.80			27
RELAXATION		12.40	-5.52			4.80			28
9.15	-.16	8.04	-33.84	-33.12	0.00	1.00	.30047963E+04	20	29
6.56	3.50	-3.56	-17.36	-33.09	0.00	35.00	.37392025E+04	21	30
RELAXATION		-3.52	-17.32			3.50			30
RELAXATION		-3.45	-17.25			3.50			31
RELAXATION		-3.38	-17.18			3.50			32
RELAXATION		-3.31	-17.11			3.50			33
RELAXATION		-3.24	-17.04			3.50			34
RELAXATION		-3.17	-16.97			3.50			35
RELAXATION		-3.10	-16.90			3.50			36
RELAXATION		-3.03	-16.83			3.50			37
RELAXATION		-2.96	-16.76			3.50			38
RELAXATION		-2.89	-16.69			3.50			39
19.45	2.10	55.00	-23.08	-32.39	-32.52	1.00	.58920931E+03	22	40
14.93	2.99	34.91	-19.08	-32.52	-12.42	9.00	.91708325E+03	23	41
10.14	5.03	13.57	-9.43	-32.07	0.00	10.00	.16047965E+04	24	42
20.09	14.18	55.00	26.37	-31.61	-35.42	1.00	.35835054E+03	25	43
-.78	-3.98	-38.93	-53.34	-35.42	0.00	1.00	.13025831E+05	26	44
22.76	14.98	55.00	20.02	-35.42	-47.41	1.00	.28748314E+03	27	45
23.67	13.69	55.00	10.09	-47.41	-51.52	1.00	.27916148E+03	28	46
14.18	8.90	12.27	-11.46	-51.52	-8.79	1.00	.75464468E+03	29	47
16.60	14.18	23.29	12.40	-51.39	-19.69	19.00	.48342514E+03	30	48
RELAXATION		23.44	12.54			1.90			48
RELAXATION		23.72	12.83			1.90			49

RELAXATION		24.00	13.11			1.90			50
RELAXATION		24.28	13.39			1.90			51
RELAXATION		24.56	13.66			1.90			52
RELAXATION		24.83	13.94			1.90			53
RELAXATION		25.11	14.21			1.90			54
RELAXATION		25.37	14.48			1.90			55
RELAXATION		25.64	14.75			1.90			56
RELAXATION		25.91	15.01			1.90			57
14.13	12.48	15.14	7.52	-48.65	-8.79	2.00	.65336542E+03	31	58
21.79	12.97	49.68	9.98	-48.37	-43.05	1.00	.32605652E+03	32	59
18.48	15.63	34.83	22.00	-48.33	-28.16	1.00	.39170979E+03	33	60
18.88	8.66	36.76	-9.24	-48.21	-29.98	1.00	.47468264E+03	34	61
12.08	10.63	6.23	-.31	-48.13	0.00	9.00	.90043347E+03	35	62
15.87	11.59	24.39	5.14	-47.03	-16.42	5.00	.56645141E+03	36	63
14.66	12.40	19.56	9.39	-46.41	-10.97	29.00	.62236611E+03	37	64
RELAXATION		19.75	9.58			2.90			64
RELAXATION		20.12	9.95			2.90			65
RELAXATION		20.50	10.33			2.90			66
RELAXATION		20.86	10.70			2.90			67
RELAXATION		21.23	11.06			2.90			68
RELAXATION		21.59	11.42			2.90			69
RELAXATION		21.94	11.78			2.90			70
RELAXATION		22.30	12.13			2.90			71
RELAXATION		22.65	12.48			2.90			72
RELAXATION		22.99	12.82			2.90			73
-.78	-3.98	-40.60	-55.00	-42.81	0.00	1.00	.13025831E+05	38	74
-1.05	-3.66	-41.80	-53.54	-37.08	0.00	1.00	.14337171E+05	39	75

THE NUMBER OF PEAKS OR VALLEYS IN THE INPUT LOAD SPECTRUM = 75

	SIGMA		
STEP	MAXIMUM	MINIMUM	COUNTER K
1	-.351045E+01	-.179154E+02	1.00000
2	.550000E+02	.428950E+02	1.00000
3	.428950E+02	.272795E+02	1.00000
4	.550000E+02	.495527E+02	1.00000
5	.550000E+02	.182008E+02	1.00000
6	.385372E+02	.294585E+02	3.00000
7	.321966E+02	-.971139E+00	1.00000
8	.465387E+02	.322548E+02	2.00000
9	.323357E+02	.232570E+02	1.00000
10	.543191E+02	.148568E+02	1.00000
11	.148601E+02	-.131024E+02	1.00000
12	.291797E+02	.148958E+02	6.00000
13	.153186E+02	.805562E+01	1.00000
14	.550000E+02	.648550E+00	1.00000
15	.272796E+02	.173800E+01	1.00000
16	.382570E+02	.399989E+01	1.00000
17	.256130E+02	.121764E+02	7.00000
18	.306127E+02	-.203494E+02	1.00000
19	.101054E+02	-.781000E+01	4.80000
20	.103674E+02	-.754800E+01	4.80000
21	.106275E+02	-.728793E+01	4.80000
22	.108856E+02	-.702978E+01	4.80000
23	.111419E+02	-.677353E+01	4.80000
24	.113962E+02	-.651917E+01	4.80000
25	.116487E+02	-.626669E+01	4.80000
26	.118993E+02	-.601607E+01	4.80000
27	.121481E+02	-.576729E+01	4.80000
28	.123950E+02	-.552036E+01	4.80000
29	.803921E+01	-.338441E+02	1.00000
30	-.352059E+01	-.173203E+02	3.50000
31	-.344941E+01	-.172491E+02	3.50000
32	-.337838E+01	-.171781E+02	3.50000

33	-.330750E+01	-.171072E+02	3.50000
34	-.323678E+01	-.170365E+02	3.50000
35	-.316621E+01	-.169659E+02	3.50000
36	-.309579E+01	-.168955E+02	3.50000
37	-.302552E+01	-.168252E+02	3.50000
38	-.295540E+01	-.167551E+02	3.50000
39	-.288544E+01	-.166851E+02	3.50000
40	.550000E+02	-.230772E+02	1.00000
41	.349057E+02	-.190826E+02	9.00000
42	.135658E+02	-.943374E+01	10.00000
43	.550000E+02	.283690E+02	1.00000
44	-.389348E+02	-.533397E+02	1.00000
45	.550000E+02	.200165E+02	1.00000
46	.550000E+02	.100905E+02	1.00000
47	.122694E+02	-.114564E+02	1.00000
48	.234369E+02	.125424E+02	1.90000
49	.237213E+02	.128268E+02	1.90000
50	.240031E+02	.131036E+02	1.90000
51	.242824E+02	.133879E+02	1.90000
52	.245592E+02	.136647E+02	1.90000
53	.248335E+02	.139390E+02	1.90000
54	.251053E+02	.142108E+02	1.90000
55	.253747E+02	.144802E+02	1.90000
56	.256416E+02	.147471E+02	1.90000
57	.259062E+02	.150117E+02	1.90000
58	.151434E+02	.751720E+01	2.00000
59	.496805E+02	.997609E+01	1.00000
60	.348288E+02	.219975E+02	1.00000
61	.367628E+02	-.923622E+01	1.00000
62	.622539E+01	-.311306E+00	9.00000
63	.243886E+02	.514165E+01	5.00000
64	.197465E+02	.957830E+01	2.90000
65	.201228E+02	.995459E+01	2.90000
66	.204951E+02	.103269E+02	2.90000
67	.208634E+02	.106952E+02	2.90000
68	.212277E+02	.110595E+02	2.90000
69	.215882E+02	.114200E+02	2.90000
70	.219448E+02	.117766E+02	2.90000
71	.222977E+02	.121295E+02	2.90000
72	.226467E+02	.124785E+02	2.90000
73	.229920E+02	.128238E+02	2.90000
74	-.405950E+02	-.550000E+02	1.00000
75	-.417990E+02	-.535408E+02	1.00000

RANGE PAIR CYCLE COUNTED SPECTRUM

STEP	SIGMA MAXIMUM	SIGMA MINIMUM	COUNTER K
1	-.351045E+01	-.179154E+02	1.00000
2	.550000E+02	.272795E+02	1.00000
3	.550000E+02	.495527E+02	1.00000
4	.550000E+02	-.550000E+02	1.00000
5	.321966E+02	.294585E+02	1.00000
6	.465387E+02	.322548E+02	1.00000
7	.465387E+02	.232570E+02	1.00000
8	.323357E+02	.322548E+02	1.00000
9	.543191E+02	-.971139E+00	1.00000
10	.148601E+02	.148568E+02	1.00000
11	.291797E+02	.148958E+02	5.00000
12	.291797E+02	.805562E+01	1.00000
13	.153186E+02	.148958E+02	1.00000
14	.550000E+02	-.131024E+02	1.00000
15	.272796E+02	.173300E+01	1.00000
16	.382570E+02	.648550E+00	1.00000
17	.306127E+02	.121764E+02	1.00000
18	.101054E+02	-.781000E+01	5.00000
19	.103674E+02	-.754800E+01	5.00000
20	.106275E+02	-.728793E+01	5.00000
21	.108856E+02	-.702978E+01	5.00000
22	.111419E+02	-.677353E+01	5.00000
23	.113962E+02	-.651917E+01	5.00000
24	.116487E+02	-.626669E+01	5.00000
25	.118993E+02	-.601607E+01	5.00000
26	.121481E+02	-.576729E+01	5.00000
27	.123950E+02	-.552036E+01	4.00000
28	.123950E+02	-.203494E+02	1.00000
29	.803921E+01	-.552036E+01	1.00000
30	-.352059E+01	-.173203E+02	4.00000
31	-.344941E+01	-.172491E+02	4.00000
32	-.337838E+01	-.171781E+02	4.00000
33	-.330750E+01	-.171072E+02	4.00000
34	-.323678E+01	-.170365E+02	4.00000
35	-.316621E+01	-.169659E+02	4.00000
36	-.309579E+01	-.168955E+02	4.00000
37	-.302552E+01	-.168252E+02	4.00000
38	-.295540E+01	-.167551E+02	4.00000
39	-.288544E+01	-.166851E+02	4.00000
40	.550000E+02	-.190826E+02	1.00000
41	.135658E+02	-.943374E+01	10.00000
42	.550000E+02	-.338441E+02	1.00000
43	.550000E+02	.200165E+02	1.00000
44	.550000E+02	-.533397E+02	1.00000
45	.234369E+02	.125424E+02	2.00000
46	.237213E+02	.128268E+02	2.00000
47	.240031E+02	.131086E+02	2.00000
48	.242824E+02	.133879E+02	2.00000
49	.245592E+02	.136647E+02	2.00000
50	.248335E+02	.139390E+02	2.00000
51	.251053E+02	.142108E+02	2.00000
52	.253747E+02	.144802E+02	2.00000
53	.256416E+02	.147471E+02	2.00000
54	.259062E+02	.150117E+02	1.00000
55	.259062E+02	.751720E+01	1.00000
56	.151434E+02	.150117E+02	1.00000

57	.151434E+02	.751720E+01	1.00000
58	.496805E+02	-.114564E+02	1.00000
59	.348288E+02	.219975E+02	1.00000
60	.367628E+02	.997609E+01	1.00000
61	.243886E+02	.514165E+01	4.00000
62	.243886E+02	-.311306E+00	1.00000
63	.197465E+02	.357830E+01	3.00000
64	.201228E+02	.995459E+01	3.00000
65	.204951E+02	.103269E+02	3.00000
66	.208634E+02	.106952E+02	3.00000
67	.212277E+02	.110595E+02	3.00000
68	.215882E+02	.114200E+02	3.00000
69	.219448E+02	.117766E+02	3.00000
70	.222977E+02	.121295E+02	3.00000
71	.226467E+02	.124785E+02	3.00000
72	.229920E+02	.128238E+02	2.00000
73	.229920E+02	.514165E+01	1.00000
74	-.417990E+02	-.535408E+02	1.00000

LOCAL STRESSES AND PLASTIC STRAINS W/RESULTING FATIGUE LIFE

STEP	PLASTIC STRAIN	MAX OR MIN	DAMAGE
2	.00636	MAX	.589085E-03
4	.00035	MAX	.236703E-05
5	.00022	MAX	.105771E-05
14	.00249	MAX	.891548E-04
22	.00004	MAX	.498022E-07
25	.00123	MAX	.242990E-04
27	.00420	MAX	.233133E-03
28	.00156	MAX	.379281E-04
38	.00063	MIN	.718916E-05

DAMAGE FROM PLASTIC STRAINS= .98426328E-03

SIGMAX	SIGMIN	RNCYC	CYCLES	ENN/CYC
-3.51	-17.92	1.	.10000000E+10	.10000000E-08
55.00	27.28	1.	.14807856E+06	.67531722E-05
55.00	49.55	1.	.69900694E+09	.14306010E-08
55.00	-55.00	1.	.10000000E+05	.10000000E-03
32.20	29.46	1.	.46901918E+12	.21321090E-11
46.54	32.25	1.	.11536870E+09	.86678619E-08
46.54	23.26	1.	.51785551E+07	.19310405E-06
32.34	32.25	1.	.36726287E+13	.27228454E-12
54.32	-.97	1.	.14931857E+05	.66970305E-04
14.86	14.86	1.	.50066416E+12	.19973463E-11
29.18	14.90	5.	.12665797E+10	.39476395E-08
29.18	8.06	1.	.14052164E+09	.71163418E-08
15.32	14.90	1.	.42187482E+12	.23703714E-11
55.00	-13.10	1.	.10000000E+05	.10000000E-03
27.28	1.74	1.	.53004668E+08	.18866263E-07
38.26	.65	1.	.17454008E+07	.57293429E-06
30.61	12.18	1.	.27966528E+09	.35757031E-08
10.11	-7.81	5.	.10000000E+10	.50000000E-08
10.37	-7.55	5.	.10000000E+10	.50000000E-08
10.63	-7.29	5.	.10000000E+10	.50000000E-08
10.89	-7.03	5.	.10000000E+10	.50000000E-08
11.14	-6.77	5.	.56054816E+09	.89198403E-08
11.40	-6.52	5.	.56088584E+09	.89144700E-08
11.65	-6.27	5.	.56115089E+09	.89102593E-08
11.90	-6.02	5.	.56134367E+09	.89071993E-08
12.15	-5.77	5.	.56146456E+09	.89052816E-08
12.40	-5.52	4.	.56151397E+09	.71235984E-08
12.40	-20.35	1.	.27376289E+08	.36527961E-07
8.04	-5.52	1.	.10000000E+10	.10000000E-08
-3.52	-17.32	4.	.10000000E+10	.40000000E-08
-3.45	-17.25	4.	.10000000E+10	.40000000E-08

-3.38	-17.18	4.	.10000000E+10	.40000000E-08
-3.31	-17.11	4.	.10000000E+10	.40000000E-08
-3.24	-17.04	4.	.10000000E+10	.40000000E-08
-3.17	-16.97	4.	.10000000E+10	.40000000E-08
-3.10	-16.90	4.	.10000000E+10	.40000000E-08
-3.03	-16.83	4.	.10000000E+10	.40000000E-08
-2.96	-16.76	4.	.10000000E+10	.40000000E-08
-2.89	-16.69	4.	.10000000E+10	.40000000E-08
55.00	-19.08	1.	.10000000E+05	.10000000E-03
13.57	-9.43	10.	.16603817E+09	.60227117E-07
55.00	-33.84	1.	.10000000E+05	.10000000E-03
55.00	20.02	1.	.63546690E+05	.15736461E-04
55.00	-53.34	1.	.10000000E+05	.10000000E-03
23.44	12.54	2.	.52786328E+10	.37888599E-09
23.72	12.83	2.	.52805280E+10	.37875000E-09
24.00	13.11	2.	.52807566E+10	.37873361E-09
24.28	13.39	2.	.52793259E+10	.37883625E-09
24.56	13.66	2.	.52762450E+10	.37905745E-09
24.83	13.94	2.	.52715248E+10	.37939687E-09
25.11	14.21	2.	.52651779E+10	.37985421E-09
25.37	14.48	2.	.52572184E+10	.38042931E-09
25.64	14.75	2.	.52476624E+10	.38112208E-09
25.91	15.01	1.	.52365271E+10	.19096626E-09
25.91	7.52	1.	.37589154E+09	.26603419E-08
15.14	15.01	1.	.48307951E+12	.20700526E-11
15.14	7.52	1.	.15515977E+11	.64449697E-10
49.68	-11.46	1.	.24152055E+05	.41404344E-04
34.83	22.00	1.	.15814258E+10	.63234078E-09
36.76	9.98	1.	.15038306E+08	.66496353E-07
24.39	5.14	4.	.31310615E+09	.12775220E-07
24.39	-.31	1.	.77428372E+08	.12915152E-07
19.75	9.58	3.	.67337984E+10	.44551379E-09
20.12	9.95	3.	.67798754E+10	.44248601E-09
20.50	10.33	3.	.68230691E+10	.43968484E-09
20.86	10.70	3.	.68633296E+10	.43710563E-09
21.23	11.06	3.	.69006119E+10	.43474405E-09
21.59	11.42	3.	.69348755E+10	.43259603E-09
21.94	11.78	3.	.69660846E+10	.43065799E-09
22.30	12.13	3.	.69942085E+10	.42892630E-09
22.65	12.48	3.	.70192214E+10	.42739783E-09
22.99	12.82	2.	.70411021E+10	.28404644E-09
22.99	5.14	1.	.49378912E+09	.20251560E-08
-41.80	-53.54	1.	.10000000E+10	.10000000E-08

DAMAGE PER THIS SET= .16162546E-02

TOTAL ENN/CYC =, .16162546E-02

FLIGHT OR BLOCK NO. 2

STMAX	STMIN	SIGMAX	SIGMIN	RES	EQRES	ENN	NEP		
-.78	-3.98	-40.58	-54.99	-37.07	0.00	1.00	.13025831E+05	1	1
18.40	15.71	45.73	33.63	-37.07	-27.80	1.00	.39342782E+03	2	2
15.71	12.24	33.68	18.07	-37.01	-15.69	1.00	.56235689E+03	3	3
18.64	17.43	46.96	41.52	-36.92	-28.89	1.00	.36717948E+03	4	4
18.80	10.63	47.74	10.94	-36.87	-29.61	1.00	.44621680E+03	5	5
15.14	13.13	31.31	22.24	-36.84	-13.15	3.00	.57667259E+03	6	6
13.69	6.32	25.06	-8.11	-36.55	-6.61	1.00	.90105168E+03	7	7
16.87	13.69	39.42	25.14	-36.48	-20.90	2.00	.47906511E+03	8	8
13.69	11.67	25.29	16.21	-36.33	-6.61	1.00	.71090397E+03	9	9
18.56	9.79	47.29	7.83	-36.23	-28.52	1.00	.46919213E+03	10	10
9.79	3.58	7.87	-20.10	-36.20	0.00	1.00	.18851779E+04	11	11
12.97	9.79	22.20	7.91	-36.15	-3.35	6.00	.83680259E+03	12	12
9.79	8.18	8.45	1.19	-35.61	0.00	1.00	.14033389E+04	13	13
20.34	8.26	55.00	.65	-35.56	-36.51	1.00	.42460525E+03	14	14
14.18	8.50	27.28	1.74	-36.51	-8.79	1.00	.76807252E+03	15	15
16.60	8.98	38.26	4.00	-36.43	-19.69	1.00	.58153350E+03	16	16
13.77	10.79	25.61	12.18	-36.36	-6.98	7.00	.72996103E+03	17	17

14.74	3.42	30.61	-20.35	-35.72	-11.34	1.00	.92247814E+03	18	18
10.14	6.16	9.97	-7.94	-35.66	0.00	48.00	.14935730E+04	19	19
RELAXATION		10.11	-7.81			4.80			19
RELAXATION		10.37	-7.55			4.80			20
RELAXATION		10.63	-7.29			4.80			21
RELAXATION		10.89	-7.03			4.80			22
RELAXATION		11.14	-6.77			4.80			23
RELAXATION		11.40	-6.52			4.80			24
RELAXATION		11.65	-6.27			4.80			25
RELAXATION		11.90	-6.02			4.80			26
RELAXATION		12.15	-5.77			4.80			27
RELAXATION		12.40	-5.52			4.80			28
9.15	-.16	8.04	-33.84	-33.12	0.00	1.00	.30047963E+04	20	29
6.56	3.50	-3.56	-17.36	-33.09	0.00	35.00	.37392025E+04	21	30
RELAXATION		-3.52	-17.32			3.50			30
RELAXATION		-3.45	-17.25			3.50			31
RELAXATION		-3.38	-17.18			3.50			32
RELAXATION		-3.31	-17.11			3.50			33
RELAXATION		-3.24	-17.04			3.50			34
RELAXATION		-3.17	-16.97			3.50			35
RELAXATION		-3.10	-16.90			3.50			36
RELAXATION		-3.03	-16.83			3.50			37
RELAXATION		-2.96	-16.76			3.50			38
RELAXATION		-2.89	-16.69			3.50			39
13.45	2.10	55.00	-23.08	-32.39	-32.52	1.00	.58920931E+03	22	40
14.98	2.99	34.91	-19.08	-32.52	-12.42	9.00	.91708325E+03	23	41
10.14	5.03	13.57	-9.43	-32.07	0.00	10.00	.16047965E+04	24	42
20.09	14.18	55.00	28.37	-31.61	-35.42	1.00	.35855054E+03	25	43
-.78	-3.98	-38.93	-53.34	-35.42	0.00	1.00	.13025831E+05	26	44
22.76	14.98	55.00	20.02	-35.42	-47.41	1.00	.28748314E+03	27	45
23.67	13.69	55.00	10.09	-47.41	-51.52	.00	.27916148E+03	28	46
14.18	8.90	12.27	-11.46	-51.52	-8.79	1.00	.75464468E+03	29	47
16.60	14.18	23.29	12.40	-51.39	-19.69	19.00	.48342514E+03	30	48
RELAXATION		23.44	12.54			1.90			48
RELAXATION		23.72	12.83			1.90			49
RELAXATION		24.00	13.11			1.90			50
RELAXATION		24.28	13.39			1.90			51
RELAXATION		24.56	13.66			1.90			52
RELAXATION		24.83	13.94			1.90			53
RELAXATION		25.11	14.21			1.90			54
RELAXATION		25.37	14.48			1.90			55
RELAXATION		25.64	14.75			1.90			56
RELAXATION		25.91	15.01			1.90			57
14.18	12.48	15.14	7.52	-48.65	-8.79	2.00	.65336542E+03	31	58
21.79	12.97	49.68	9.98	-48.37	-43.05	1.00	.32605652E+03	32	59
18.48	15.63	34.83	22.00	-48.33	-28.16	1.00	.39170979E+03	33	60
16.88	8.66	36.76	-9.24	-48.21	-29.98	1.00	.47468264E+03	34	61
12.08	10.63	6.23	-.31	-48.13	0.00	9.00	.90043347E+03	35	62
15.87	11.59	24.39	5.14	-47.03	-16.42	5.00	.56645141E+03	36	63
14.66	12.40	19.56	9.39	-46.41	-10.97	29.00	.62236611E+03	37	64
RELAXATION		19.75	9.58			2.90			64
RELAXATION		20.12	9.95			2.90			65
RELAXATION		20.50	10.33			2.90			66
RELAXATION		20.86	10.70			2.90			67
RELAXATION		21.23	11.06			2.90			68
RELAXATION		21.59	11.42			2.90			69
RELAXATION		21.94	11.78			2.90			70
RELAXATION		22.30	12.13			2.90			71
RELAXATION		22.65	12.48			2.90			72
RELAXATION		22.99	12.82			2.90			73
-.78	-3.98	-40.60	-55.00	-42.81	0.00	1.00	.13025831E+05	38	74
-1.05	-3.66	-41.80	-53.54	-37.08	0.00	1.00	.14337171E+05	39	75

LOCAL STRESSES AND PLASTIC STRAINS W/RESULTING FATIGUE LIFE

STEP	PLASTIC STRAIN	MAX OR MIN	DAMAGE
14	.00032	MAX	.202856E-05
22	.00004	MAX	.498022E-07
25	.00123	MAX	.242990E-04
27	.00420	MAX	.233133E-03
28	.00156	MAX	.379281E-04
38	.00063	MIN	.718916E-05

DAMAGE FROM PLASTIC STRAINS= .30462764E-03

SIGMAX	SIGMIN	RNCYC	CYCLES	ENN/CYC
-40.58	-54.99	1.	.10000000E+10	.10000000E-08
45.73	18.07	1.	.24093777E+07	.41504493E-06
33.68	33.63	1.	.43206072E+13	.23144895E-12
46.96	41.52	1.	.23661145E+11	.42263381E-10
47.74	-20.10	1.	.19780666E+05	.50554416E-04
25.06	22.24	1.	.27937764E+12	.35793846E-11
39.42	25.14	1.	.50516846E+09	.19795377E-08
39.42	16.21	1.	.24432813E+08	.40928567E-07
25.29	25.14	1.	.15753982E+13	.63476016E-12
47.23	-8.11	1.	.58801786E+05	.17006285E-04
7.87	7.83	1.	.10000000E+10	.10000000E-08
22.20	7.91	5.	.15461310E+10	.32338787E-08
22.20	1.19	1.	.21206560E+09	.47155219E-08
8.45	7.91	1.	.10000000E+10	.10000000E-08
55.00	-53.34	1.	.10000000E+05	.10000000E-03
27.28	1.74	1.	.53004668E+08	.18866263E-07
38.26	.65	1.	.17454008E+07	.57293429E-06
30.61	12.18	1.	.27966528E+09	.35757031E-08
10.11	-7.81	5.	.10000000E+10	.50000000E-08
10.37	-7.55	5.	.10000000E+10	.50000000E-08
10.63	-7.29	5.	.10000000E+10	.50000000E-08
10.89	-7.03	5.	.10000000E+10	.50000000E-08
11.14	-6.77	5.	.56054816E+09	.89198403E-08
11.40	-6.52	5.	.56088584E+09	.89144700E-08
11.65	-6.27	5.	.56115089E+09	.89102593E-08
11.90	-6.02	5.	.56134367E+09	.89071993E-08
12.15	-5.77	5.	.56146456E+09	.89052816E-08
12.40	-5.52	4.	.56151397E+09	.71235984E-08
12.40	-20.35	1.	.27376289E+08	.36527961E-07
8.04	-5.52	1.	.10000000E+10	.10000000E-08
-3.52	-17.32	4.	.10000000E+10	.40000000E-08
-3.45	-17.25	4.	.10000000E+10	.40000000E-08
-3.38	-17.18	4.	.10000000E+10	.40000000E-08
-3.31	-17.11	.	.10000000E+10	.40000000E-08
-3.24	-17.04	.	.10000000E+10	.40000000E-08
-3.17	-16.97	.	.10000000E+10	.40000000E-08
-3.10	-16.90	4.	.10000000E+10	.40000000E-08
-3.03	-16.83	4.	.10000000E+10	.40000000E-08
-2.96	-16.76	4.	.10000000E+10	.40000000E-08
-2.89	-16.69	4.	.10000000E+10	.40000000E-08
55.00	-19.08	1.	.10000000E+05	.10000000E-03
13.57	-9.43	10.	.16603817E+09	.60227117E-07
55.00	-33.84	1.	.10000000E+05	.10000000E-03
55.00	20.02	1.	.63546690E+05	.15736461E-04
55.00	-55.00	1.	.10000000E+05	.10000000E-03
23.44	12.54	2.	.52786328E+10	.37888539E-09
23.72	12.83	2.	.52805280E+10	.37875000E-09
24.00	13.11	2.	.52807566E+10	.37873361E-09
24.28	13.39	2.	.52793259E+10	.37883625E-09
24.56	13.66	2.	.52762450E+10	.37905745E-09
24.83	13.94	2.	.52715248E+10	.37939687E-09
25.11	14.21	2.	.52651779E+10	.37985421E-09
25.37	14.48	2.	.52572184E+10	.38042931E-09
25.64	14.75	2.	.52476624E+10	.38112208E-09
25.91	15.01	1.	.52365271E+10	.19096626E-09
25.91	7.52	1.	.37589154E+09	.26603419E-08

15.14	15.01	1.	.48307951E+12	.20700526E-11
15.14	7.52	1.	.15515977E+11	.64449697E-10
49.68	-11.46	1.	.24152055E+05	.41404344E-04
34.83	22.00	1.	.15814258E+10	.63234078E-09
36.76	9.98	1.	.15038306E+08	.66496853E-07
24.39	5.14	4.	.31310615E+09	.12775220E-07
24.39	-.31	1.	.77428372E+08	.12915162E-07
19.75	9.58	3.	.67337984E+10	.44551379E-09
20.12	9.95	3.	.67798754E+10	.44248601E-09
20.50	10.33	3.	.68230691E+10	.43968484E-09
20.86	10.70	3.	.68633296E+10	.43710563E-09
21.23	11.06	3.	.69006119E+10	.43474405E-09
21.59	11.42	3.	.69348755E+10	.43259609E-09
21.94	11.78	3.	.69660846E+10	.43065799E-09
22.30	12.13	3.	.69942085E+10	.42892630E-09
22.65	12.48	3.	.70192214E+10	.42739783E-09
22.99	12.82	2.	.70411021E+10	.28404644E-09
22.99	5.14	1.	.49378912E+09	.20251560E-08
-41.80	-53.54	1.	.10000000E+10	.10000000E-08

DAMAGE PER THIS SET= .83070929E-03

TOTAL ENN/CYC =, .24469639E-02

FLIGHT OR BLOCK NO. 3

STMAX	STMIN	SIGMAX	SIGMIN	RES	EQRES	ENN	NEP		
-.78	-3.98	-40.58	-54.99	-37.07	0.00	1.00	.13025831E+05	1	1
24.08	15.71	55.00	17.35	-37.07	-53.34	1.00	.25777999E+03	2	2
18.40	15.71	29.46	17.35	-53.34	-27.80	1.00	.39342782E+03	3	3
15.71	12.24	17.50	1.89	-53.19	-15.69	1.00	.56235689E+03	4	4
18.64	17.43	30.85	25.40	-53.04	-28.89	1.00	.36717948E+03	5	5
18.30	10.63	31.73	-5.07	-52.89	-29.61	1.00	.44621680E+03	6	6
15.14	13.13	15.38	6.31	-52.77	-13.15	3.00	.57667259E+03	7	7
13.69	6.32	9.32	-23.85	-52.29	-6.61	1.00	.90105168E+03	8	8
16.87	13.69	23.72	9.44	-52.18	-20.90	2.00	.47906511E+03	9	9
13.69	11.67	9.74	.66	-51.88	-6.61	1.00	.71090397E+03	10	10
18.56	9.79	31.79	-7.67	-51.73	-28.52	1.00	.46919213E+03	11	11
9.79	3.58	-7.56	-35.52	-51.62	0.00	1.00	.18861779E+04	12	12
12.97	9.79	6.79	-7.49	-51.56	-3.35	6.00	.83680259E+03	13	13
9.79	8.18	-6.70	-13.97	-50.77	0.00	1.00	.14033389E+04	14	14
20.34	8.26	40.83	-13.52	-50.68	-36.51	1.00	.42460525E+03	15	15
14.18	8.50	13.19	-12.35	-50.61	-8.79	1.00	.76807252E+03	16	16
19.05	14.66	35.22	15.49	-50.48	-30.70	1.00	.38464145E+03	17	17
16.50	8.98	24.32	-9.93	-50.36	-19.69	1.00	.58153350E+03	18	18
13.77	10.79	11.74	-1.70	-50.24	-6.98	7.00	.72996103E+03	19	19
14.74	3.42	17.04	-33.92	-49.30	-11.34	1.00	.92247814E+03	20	20
10.14	6.16	-3.57	-21.48	-49.20	0.00	48.00	.14935730E+04	21	21
RELAXATION		-3.39	-21.30			4.80			21
RELAXATION		-3.02	-20.94			4.80			22
RELAXATION		-2.66	-20.58			4.80			23
RELAXATION		-2.31	-20.22			4.80			24
RELAXATION		-1.96	-19.87			4.80			25
RELAXATION		-1.60	-19.52			4.80			26
RELAXATION		-1.26	-19.17			4.80			27
RELAXATION		-.91	-18.83			4.80			28
RELAXATION		-.57	-18.48			4.80			29
RELAXATION		-.23	-18.14			4.80			30
9.15	-.16	-4.54	-46.42	-45.69	0.00	1.00	.30047963E+04	22	31
6.56	3.50	-16.12	-29.92	-45.66	0.00	35.00	.37392025E+04	23	32
RELAXATION		-16.07	-29.87			3.50			32
RELAXATION		-15.97	-29.77			3.50			33
RELAXATION		-15.88	-29.68			3.50			34
RELAXATION		-15.78	-29.58			3.50			35
RELAXATION		-15.68	-29.48			3.50			36
RELAXATION		-15.58	-29.38			3.50			37
RELAXATION		-15.49	-29.29			3.50			38
RELAXATION		-15.39	-29.19			3.50			39

RELAXATION		-15.29	-29.09			3.50			40
RELAXATION		-15.20	-29.00			3.50			41
19.45	2.10	42.84	-35.24	-44.68	-32.52	1.00	.58920931E+03	24	42
14.98	2.99	22.79	-31.20	-44.64	-12.42	9.00	.91708325E+03	25	43
10.14	5.03	1.72	-21.28	-43.92	0.00	10.00	.16047965E+04	26	44
23.75	-3.23	60.71	-60.71	-43.29	-51.89	1.00	.50647169E+03	27	45
20.09	14.18	44.22	17.59	-46.21	-35.42	1.00	.35855054E+03	28	46
-.78	-3.98	-40.60	-55.00	-46.14	0.00	1.00	.13025831E+05	29	47
22.76	14.98	55.00	20.02	-37.08	-47.41	1.00	.28748314E+03	30	48
23.67	13.69	55.00	10.09	-47.41	-51.52	1.00	.27916148E+03	31	49
14.18	8.90	12.27	-11.46	-51.52	-8.79	1.00	.75464468E+03	32	50
16.50	14.18	23.29	12.40	-51.39	-19.69	19.00	.48342514E+03	33	51
RELAXATION		23.44	12.54			1.90			51
RELAXATION		23.72	12.83			1.90			52
RELAXATION		24.00	13.11			1.90			53
RELAXATION		24.28	13.39			1.90			54
RELAXATION		24.56	13.66			1.90			55
RELAXATION		24.83	13.94			1.90			56
RELAXATION		25.11	14.21			1.90			57
RELAXATION		25.37	14.48			1.90			58
RELAXATION		25.64	14.75			1.90			59
RELAXATION		25.91	15.01			1.90			60
14.18	12.48	15.14	7.52	-48.65	-8.79	2.00	.65336542E+03	34	61
21.79	12.97	49.68	9.98	-48.37	-43.05	1.00	.32605652E+03	35	62
18.48	15.63	34.83	22.00	-48.33	-28.16	1.00	.39170979E+03	36	63
18.88	8.66	36.76	-9.24	-48.21	-29.98	1.00	.47468264E+03	37	64
12.08	10.63	6.23	-.31	-48.13	0.00	9.00	.90043347E+03	38	65
15.87	11.59	24.39	5.14	-47.03	-16.42	5.00	.56645141E+03	39	66
14.66	12.40	19.56	9.39	-46.41	-10.97	29.00	.62236611E+03	40	67
RELAXATION		19.75	9.58			2.90			67
RELAXATION		20.12	9.95			2.90			68
RELAXATION		20.50	10.33			2.90			69
RELAXATION		20.86	10.70			2.90			70
RELAXATION		21.23	11.06			2.90			71
RELAXATION		21.59	11.42			2.90			72
RELAXATION		21.94	11.78			2.90			73
RELAXATION		22.30	12.13			2.90			74
RELAXATION		22.65	12.48			2.90			75
RELAXATION		22.99	12.82			2.90			76
-.78	-3.98	-40.60	-55.00	-42.81	0.00	1.00	.13025831E+05	41	77
-1.05	-3.66	-41.80	-53.54	-37.08	0.00	1.00	.14337171E+05	42	78

LOCAL STRESSES AND PLASTIC STRAINS W/RESULTING FATIGUE LIFE

STEP	PLASTIC STRAIN	MAX OR MIN	DAMAGE
2	.00593	MAX	.438461E-03
27	.00321	MAX	.141845E-03
29	.00105	MIN	.183981E-04
30	.00365	MAX	.180144E-03
31	.00156	MAX	.379281E-04
41	.00063	MIN	.718916E-05

DAMAGE FROM PLASTIC STRAINS= .82396546E-03

SIGMAX	SIGMIN	RNCY	CYCLES	ENN/CYC
-40.58	-54.99	1.	.10000000E+10	.10000000E-08
55.00	-46.42	1.	.10000000E+05	.10000000E-03
29.46	17.35	1.	.29397878E+10	.34016060E-09
17.50	17.35	1.	.63030870E+12	.15872797E-11
30.85	25.40	1.	.77590688E+11	.12888145E-10
31.73	1.89	1.	.14305010E+08	.69905579E-07
9.32	6.31	1.	.10000000E+10	.10000000E-08
23.72	9.44	1.	.15092544E+10	.66257884E-09
23.72	.66	1.	.11830863E+09	.84524691E-08
9.74	9.44	1.	.10000000E+10	.10000000E-08
31.79	-23.85	1.	.46704942E+06	.21411011E-05

-7.56	-7.67	1.	.10000000E+10	.10000000E-08
6.79	-7.49	5.	.10000000E+10	.50000000E-08
6.79	-13.97	1.	.10000000E+10	.10000000E-08
-6.70	-7.49	1.	.10000000E+10	.10000000E-08
40.83	-35.52	1.	.26004162E+05	.38455383E-04
13.19	-12.35	1.	.97971982E+08	.10207000E-07
35.22	-13.52	1.	.65291215E+06	.15315996E-05
11.74	-1.70	7.	.19249496E+10	.36364588E-08
17.04	-9.93	1.	.66014698E+08	.15148142E-07
-3.02	-20.94	5.	.10000000E+10	.50000000E-08
-2.66	-20.58	5.	.10000000E+10	.50000000E-08
-2.31	-20.22	5.	.10000000E+10	.50000000E-08
-1.96	-19.87	5.	.10000000E+10	.50000000E-08
-1.60	-19.52	5.	.10000000E+10	.50000000E-08
-1.26	-19.17	5.	.10000000E+10	.50000000E-08
-.91	-18.83	5.	.10000000E+10	.50000000E-08
-.57	-18.48	5.	.10000000E+10	.50000000E-08
-.23	-18.14	4.	.10000000E+10	.40000000E-08
-.23	-21.30	1.	.10000000E+10	.10000000E-08
-4.54	-18.14	1.	.10000000E+10	.10000000E-08
-16.07	-29.87	4.	.10000000E+10	.40000000E-08
-15.97	-29.77	4.	.10000000E+10	.40000000E-08
-15.88	-29.68	4.	.10000000E+10	.40000000E-08
-15.78	-29.58	4.	.10000000E+10	.40000000E-08
-15.68	-29.48	4.	.10000000E+10	.40000000E-08
-15.58	-29.38	4.	.10000000E+10	.40000000E-08
-15.49	-29.29	4.	.10000000E+10	.40000000E-08
-15.39	-29.19	4.	.10000000E+10	.40000000E-08
-15.29	-29.09	4.	.10000000E+10	.40000000E-08
-15.20	-29.00	4.	.10000000E+10	.40000000E-08
42.84	-31.20	1.	.24336594E+05	.41006136E-04
1.72	-21.28	10.	.10000000E+10	.10000000E-07
60.71	-55.00	1.	.10000000E+05	.10000000E-03
55.00	20.02	1.	.63546690E+05	.15736461E-04
55.00	-55.00	1.	.10000000E+05	.10000000E-03
23.44	12.54	2.	.52786328E+10	.37888599E-09
23.72	12.83	2.	.52805280E+10	.37875000E-09
24.00	13.11	2.	.52807566E+10	.37873361E-09
24.28	13.39	2.	.52793259E+10	.37883625E-09
24.56	13.66	2.	.52762450E+10	.37905745E-09
24.83	13.94	2.	.52715248E+10	.37939687E-09
25.11	14.21	2.	.52651779E+10	.37985421E-09
25.37	14.48	2.	.52572184E+10	.38042931E-09
25.64	14.75	2.	.52476624E+10	.38112208E-09
25.91	15.01	1.	.52365271E+10	.19096626E-09
25.91	7.52	1.	.37539154E+09	.26603419E-08
15.14	15.01	1.	.48307951E+12	.20700526E-11
15.14	7.52	1.	.15515977E+11	.64449697E-10
49.68	-11.46	1.	.24152055E+05	.41404344E-04
34.83	22.00	1.	.15814258E+10	.63234078E-09
36.76	9.98	1.	.15038306E+08	.66496853E-07
24.39	5.14	4.	.31310615E+09	.12775220E-07
24.39	-.31	1.	.77428372E+08	.12915162E-07
19.75	9.58	3.	.67337984E+10	.44551379E-09
20.12	9.95	3.	.67798754E+10	.44248601E-09
20.50	10.33	3.	.68230691E+10	.43968484E-09
20.86	10.70	3.	.68633296E+10	.43710563E-09
21.23	11.06	3.	.69006119E+10	.43474405E-09
21.59	11.42	3.	.69348755E+10	.43259609E-09
21.94	11.78	3.	.69660846E+10	.43065799E-09
22.30	12.13	3.	.69942085E+10	.42892630E-09
22.65	12.48	3.	.70192214E+10	.42739783E-09
22.99	12.82	2.	.70411021E+10	.28404644E-09
22.99	5.14	1.	.49378912E+09	.20251560E-08
-41.80	-53.54	1.	.10000000E+10	.10000000E-08

```
                                     DAMAGE PER THIS SET=   .12645622E-02
                                      TOTAL ENN/CYC =,   .37115261E-02
FLIGHT OR BLOCK NO.    4
                                     DAMAGE FROM PLASTIC STRAINS=   .30462764E-03
                                     DAMAGE PER THIS SET=   .83070929E-03
                                      TOTAL ENN/CYC =,   .45422354E-02
FLIGHT OR BLOCK NO.    5
                                     DAMAGE FROM PLASTIC STRAINS=   .22665690E-02
                                     DAMAGE PER THIS SET=   .26509046E-02
                                      TOTAL ENN/CYC =,   .71931400E-02
FLIGHT OR BLOCK NO.    6
                                     DAMAGE FROM PLASTIC STRAINS=   .30462764E-03
                                     DAMAGE PER THIS SET=   .83070929E-03
                                      TOTAL ENN/CYC =,   .80238493E-02
FLIGHT OR BLOCK NO.    7
                                     DAMAGE FROM PLASTIC STRAINS=   .30462764E-03
                                     DAMAGE PER THIS SET=   .83070929E-03
                                      TOTAL ENN/CYC =,   .88545586E-02
```

```
                                              CDC 6600 FTN V3.0-367A OPT=1  03/26/74  19.09.02.    PAGE    1
 1   1   1
3-1 SPECTRUM  --  TRUNCATION LEVEL  270,000 CYCLES
2219-T851 AL        55.          .49              -1.836     10000.
-.00217            .22041        55.82462   NORTH AMERICAN   4   2219
-.00178            .33210        48.26657   NORTH AMERICAN   5   2219
-.01149            .46283        39.66455   NORTH AMERICAN   6   2219
-.01243            .64139        31.70955   NORTH AMERICAN   7   2219
2500000.             1.           1.
4.5
           7         44        3
  26.9
```

1	1	-.148	-.029	1.
2	3	.584	1.	1.
3	2	.584	.895	1.
4	1	.584	.684	1.
5	1	.455	.584	1.
6	1	.648	.693	1.
7	1	.335	.699	1.
8	1	.488	.563	3.
9	1	.235	.509	1.
10	1	.529	.627	2.
11	1	.434	.509	1.
12	1	.364	.69	1.
13	1	.133	.364	1.
14	1	.364	.482	6.
15	1	.304	.364	1.
16	1	.307	.756	1.
17	1	.316	.527	1.
18	2	.545	.798	1.
19	1	.334	.617	1.
20	1	.401	.512	7.
21	1	.127	.548	1.
22	1	.229	.377	48.
23	1	-.006	.340	1.
24	1	.13	.244	35.
25	1	.278	.723	1.
26	1	.111	.557	9.
27	1	.187	.377	10.
28	3	.527	.931	1.
29	2	-.12	.883	1.
30	1	.527	.747	1.
31	1	-.148	-.029	1.
32	1	.557	.846	1.
33	1	.509	.889	1.
34	1	.331	.527	1.
35	1	.527	.617	19.
36	1	.464	.527	2.
37	1	.432	.81	1.
38	1	.581	.687	1.
39	1	.322	.702	1.
40	1	.335	.449	9.
41	1	.431	.59	5.
42	1	.461	.545	29.
43	1	-.148	-.029	1.
44	1	-.135	-.039	1.

```
                   1    1
                   2    1
                   3    2    1
                   4    1
      60           5    3    1
                   6    1
                   7    1
```

APPENDIX III

LIST OF COMPUTER PROGRAM SYMBOLS AND DEFINITIONS

A	Coefficient of the x^2 term in the equation of a line on a constant life fatigue diagram where minimum stress is x and maximum stress is y. $(R = Ax^2 + Bx + C - y)$
AA	An assigned value of +1. or -1.
AAA	A stress used in the calculation of plastic strain.
ABDIF	The absolute value of DIF.
ABM	The absolute value of ASMAX or of ASMIN, as assigned.
ABMAX	The absolute value of ASMAX.
ABMEAN	The absolute value of ASMEAN.
ABMIN	The absolute value of ASMIN.
ABR4	The absolute value of R(4).
ABR7	The absolute value of R(7).
ABS	The name of a routine calling for the absolute value of a quantity.
AKT	Stress concentration factor, K_t
ASMAX	The product (AKT) (STMAX)
ASMEAN	The quantity (ASMAX + ASMIN)/2
ASMIN	The product (AKT) (STMIN)
AVSGMN	Average value of SIGMIN over an interval.
AVSGMX	Average value of SIGMAX over an interval.

B	Coefficient of the x term. (See A.)
BBB	A stress used in the calculation of plastic strain.
C	The constant. (See A.)
COFMAN	Inverse of the Coffin-Manson slope.
CYCINT	The number of cycles in an interval.
CYCLES	The calculated number of cycles expected to be indicated on a constant life fatigue diagram for the applied combination of maximum and minimum stress.
C1	The Residual Stress Relaxation Constant (See ENEP.)
DAM	Damage.
DECK	Decimal or real value of integer K after conversion.
DEL2	A portion of a least-squares-method solution.
DIF	The difference between residual stress and equilibrium residual stress. (RES(I) - EQRES)
DO2	A portion of a least-squares-method solution.
DUMMY	A variable used in the calculation of the number of cycles to be considered as an interval for relaxation determination.
ELMOD	The elastic modulus.
EN	The number of cycles from the beginning of the relaxation process to the end of the current interval.
ENEP	The number of cycles required for overload residual stress effect to return to within one-tenth of its original difference from equilibrium conditions. ($N_{ep} = C1/(ABM)^{E1}(ABMEAN)^{E2}$)

ENN	The number of applied cycles at a load level.
ENNCYC	The ratio of the number of applied cycles to the number of cycles to failure. (ENN/CYCLES)
EPSD	LCF strain intercept.
EQRES	Equilibrium residual stress.
EX	An exponential function depicting the relaxation of residual stress.
EXP	The name of a routine calling for the exponential value of a quantity.
EXPO	An exponent. The power of 10 which indicates the number of cycles to failure.
E1, E2	Residual stress Relaxation Exponents.
FLOAT	The name of a routine calling for integer-to-real conversion.
I	A variable subscript.
IBLOCK	The identifying number of a block the blocks being numbered consecutively from 1 to NBLOCK.
IFIX	The name of a routine calling for real-to-integer conversion.
IN	The number of steps input to the range pair counting subroutine.
IPRINT	Value controlling the WRITE statements.
IRAIN	A counter.
IRPCM	Value controlling entry into the range pair counting subroutine.

ISTEP	The identifying step number, the steps being numbered from 1 to NLEVEL.
ITYPE	The identifying type number, the types being numbered from 1 to NTYPE.
J	A variable subscript.
JA	Value of +1 or 0, as assigned for branch determination.
JB	Value of -1 or 0, as assigned for branch determination.
JJ	An index variable.
JJJ	An index variable.
JKL	An index variable.
K	An index variable.
KK	An index variable.
KPMAX	The number of steps output from the range pair counting subroutine.
L	An index variable.
LMN	An index variable.
M	An index variable.
N	An index variable with values of N=4-7 indicating the power of 10, and thus identifying a particular life cycle curve.
NBLOCK	The total number of times to execute a block of loads.
NDECK	The number of data decks to be run sequentially.
NFLAG	An integer used as a counter.
NFLAG2	An integer used as a counter.

NLEVEL	The total number of steps, or levels, of loads in a block.
NN	A subscripted variable used to indicate which types of loads are experienced in which blocks.
NTYPE	The total number of different types.
PLSTRA	Plastic strain.
R	Residue term in damage calculation.
RES	Residual stress.
RNCYC	The number of cycles for a level after exitting the range pair counting subroutine.
SIGMAX	Maximum stress.
SIGMIN	Minimum stress.
STMAX	Maximum applied stress.
STMIN	Minimum applied stress.
SUMDEL	Summation of damage for a flight.
SUMENN	Accumulated total of applied cycles. (Summation of ENN).
SUMNC	Accumulated cycle ratio. (Summation of ENN/CYCLES).
SUMR	Summation of R(N), N=4,7.
SUMRN	Summation of N R(N), N=4,7.
SUMR2	Summation of $R(N)^2$, N=4,7.
SUMR2N	Summation of $N R(N)^2$, N=4,7.
SUMR3	Summation of $R(N)^3$, N=4,7.
SUMR4	Summation of $R(N)^4$, N=4,7.
TITLE1,TITLE2	Identification of the source of the SN data.
TLL	Tensile load limit.
TM1,TM2	Material type.

TTYS One-fifth of tensile yield stress.

TYS Tensile yield stress.

T1,T2,T3,T4,T5,T6,T7,T8 Test identifying information.

X Variable equivalent to SIGMIN.

Y Variable equivalent to SIGMAX.

APPENDIX IV

FATIGUE LIFE INPUT DATA FOR SEVERAL MATERIALS

MATERIAL	YIELD STRESS	STRAIN INTERCEPT	INVERSE OF SLOPE	LIFE, 10^I	S-N LIFE COEFFICIENTS A(I)	B(I)	C(I)
2024-T4	58.	0.4 (2)	-1.836 (2)	4	-.0020	.2091	62.6 (3)
				5	-.0032	.4366	51.4
				6	-.0035	.6207	42.2
				7	-.0042	.7003	36.1
2219-T851	55.	0.4 (2)	-1.836 (2)	4	-.0022	.2204	55.8 (4)
				5	-.0018	.3320	48.3
				6	-.0015	.4628	39.7
				7	-.0024	.6420	31.7
7075-T6	72.	0.4 (1)	-1.836 (1)	4	-.0020	.2801	71.7 (3)
				5	-.0022	.5154	56.3
				6	-.0014	.6141	44.6
				7	-.0013	.6838	38.1
RQC-100	125.	0.54 (5)	-1.493 (5)	4	0.0	.2136	98.3 (5)
				5	0.0	.2927	88.5
				6	0.0	.3669	79.1
				7	0.0	.4376	70.3
Man-Ten	55.	1.11 (5)	-1.667 (5)	4	0.0	.2257	63.5 (5)
				5	0.0	.3520	53.1
				6	0.0	.4669	43.7
				7	0.0	.5678	35.4
4340 Steel	160.	0.4 (2)	-1,836 (2)	4	-.0002	.2567	162.4 (3)
				5	-.0007	.5248	126.9
				6	-.0005	.5557	113.5
				7	-.0005	.5557	108.5
Ti-6-4	158.	0.4 (2)	-1.836 (2)	4	-.0009	.2368	154.2 (3)
				5	-.0006	.4640	110.3
				6	-.0000	.4650	88.9
				7	.0001	.4752	84.2

(1) Data from Endo, T., and Morrow, J., NAEC-ASL-1105, Naval Air Engineering Center, Philadelphia, PA, June 1966.

(2) Data not available - Source 1 data considered typical.

(3) Derived from Metallic Materials and Elements for Aerospace Vehicles Structures, MIL-HDBK-5A, Dept. of Defense, Washington, D.C., February 1966.

(4) Information supplied from Rockwell International.

(5) Information supplied by Society of Automotive Engineers Cumulative Damage Division, Courtesy of Mr. H.R. Jaekel.

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